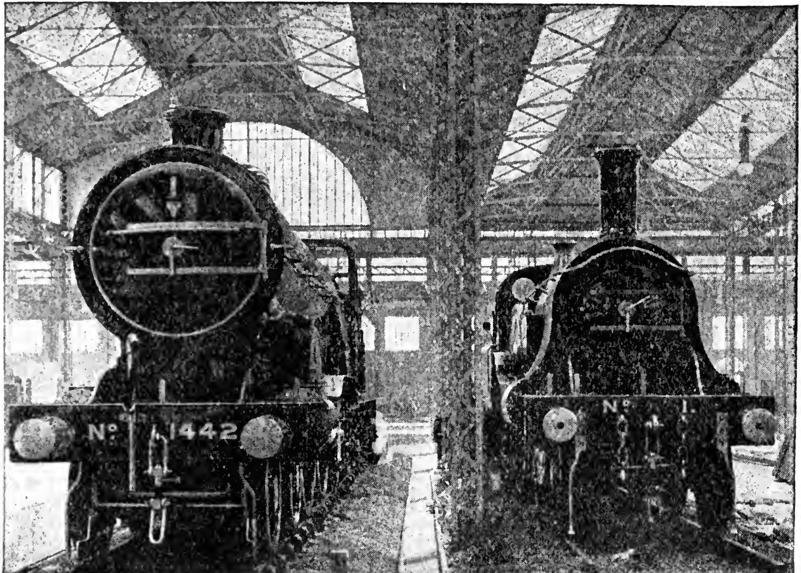
# THE STORY OF LOCOMOTION

*Frontispiece.*






A COMPARISON—GREAT NORTHERN RAILWAY COMPANY'S LOCOMOTIVES OF 1912 AND 1872.

# THE STORY OF
# LOCOMOTION

Wilson, B.

REVISED BY

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*FULLY ILLUSTRATED*

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# PREFACE.

It has been said that "when the nineteenth century takes its place with the other centuries, in the chronological charts of the future, it will, if it need a symbol, almost inevitably have as that symbol, a steam engine running upon a railway."*

The characteristic material problem of the nineteenth century was rapid locomotion, and it promises to be one of the most prominent sciences of the twentieth. To it is consecrated to-day more capital, labour and ingenuity than to all the other sciences together. It is an end to which the greatest inventors and most skilful engineers have consecrated their talents. Whether it be in the form of the railway—steam or electric—the steamship, the telegraph, with or without wires, the telephone, the electric tram, the automobile, ever great and still greater velocity of locomotion or communication is the goal in view. And what victories have been won over the sluggish forces of nature!—what obstacles overcome! The whole story is so modern, that like Electricity and Photography we can trace its beginnings not further back than the time of our grandsires.

* H. G. Wells: *Anticipations.*

Wonderful as has been the story of locomotion in the past, and marvellous as the progress has been from decade to decade, the changes of the present time are even more remarkable. Glancing back over a period of but ten short years, one feels as though some mighty magician had been at work, calling into existence new forces, new methods, and even a new population; for wherever the means of locomotion are facilitated, there do we find people thronging in ever-increasing numbers. What the next ten years may bring forth no man can foretell with any degree of certainty. We can only patiently wait and continue to ask ourselves whether it is possible for the wonders that are to come to equal those of the years that have gone. Meanwhile, a study of the history of this fascinating subject cannot fail to prove both interesting and instructive.

In the following pages an attempt has been made to give not only the history of the latest developments of locomotion, but also briefly to indicate the means by which results so remarkable have been achieved.

# THE STORY OF LOCOMOTION.

## CHAPTER I.

ECONOMY of time was a virtue so little practised by our ancestors that the innovator who proposed to effect a saving of it was regarded as either fool or revolutionary. To a race which lived in the constant prospect of eternity this life at best was but a "fleeting show," and any attempt to multiply its moments was frowned upon as vanity.

An idea of seventeenth century celerity may be gained from the fact that in 1609 to send a letter from York to Oxford and obtain a reply required a full month. Even after the establishment of the post in 1660, correspondence was but little expedited. When coaches were introduced it was roundly declared that they would ruin the country; and we find in one chronicler a eulogy of the old waggons of Master Stow's day which did *not* jog along the highway at a speed of four miles an hour, but travelled easily, "without jolting men's bodies or hurrying them along." The general advantages of rapid transit, on its commercial side, were not even dimly perceived. The new stage-coaches were condemned by the

country towns because they would enable London to avail itself of a wider circle of supply and demand, and so injure their trade. In 1673, it took a full week of travel to reach Exeter from London (the fare, by the way, being 40s. in summer and 45s. in winter, which was also the tariff for the journey from the capital to Chester or York). In 1678, six days were required by a six-horse coach to perform the journey between Edinburgh and Glasgow and return. Before the close of the seventeenth century a similar vehicle demanded two days for the journey from London to Cambridge, fifty-seven miles; while another half century was to elapse before the ordinary journey to Oxford required less time. All travelling was done by daylight: when night journeys were first introduced in 1740, there were many who foreboded ruin to the proprietors on account of the innovation.

One who thought of leaving by coach from Edinburgh for the British capital in the middle of the eighteenth century, planned the journey months in advance, consulted his lawyer and made his will. Such an adventure was not to be embarked upon lightly, as is testified by an advertisement in the *Edinburgh Courant* for 1758, which states that, "with God's permission," the coach would "go in ten days in summer and twelve in winter." This would now suffice to carry a traveller from Edinburgh to Chicago or to Cairo, with two or three days to spare. An idea of what the enterprising projectors meant by a "flying-coach" may be derived from an announcement in 1765 that such a vehicle,

drawn by eight horses, would travel from London to Dover, seventy-one miles, in a single day.

But we must remember that speed in transit was in those early days dependent on something more than the mere will of the coachman or coach-owner. The condition of the roads, not merely in this kingdom but throughout Europe generally, made rapid locomotion impossible. For centuries most of the roads were mere tracks across the face of the country, patched with rude paving in the muddy places and "very noisome and tedious to travel on and dangerous to all passengers and carriages," to quote the statute act for the repair of the highways passed in Mary's reign.

We may say that the first effort in the direction of real improvement dates from the passing of the Turnpike Act in 1633, which premised that portions of the Great North Road leading from the capital to York and Scotland were "very ruinous and become almost impassible, insomuch that it is become very dangerous to all His Majesty's liege people to pass that way." The toll-gate is an institution that began in the reign of Charles II.—the first turnpike toll being erected on the road running from Hertfordshire to the counties of Huntingdon and Cambridge. Travellers, of course, at first resisted the innovation, which was designed for their benefit; improvement was slow and the roads of England and Scotland a century later were but little bettered; indeed, some of them grew worse. We could hardly require better testimony as to

their actual condition in 1770 than is furnished by the celebrated Arthur Young in his "Tour." Speaking of a highway in Lancashire, he declares: "I know not, in the whole range of language, terms sufficiently expressive to describe this infernal road. To look over a map and perceive that it is the principal one, not only to some towns, but even whole counties, one would naturally conclude it to be at least decent; but let me most seriously caution all travellers who may accidentally purpose to travel this terrible county to avoid it as they would the devil, for a thousand to one but they break their necks or their limbs by overthrows or breakings down. They will here meet with ruts which I measured, four feet deep, and floating with mud, only from a wet summer—what, therefore, must it be after a winter? The only mending it receives in places is the tumbling in some loose stones, which serve no other purpose but jolting a carriage in the most unbearable manner. These are not merely opinions, but facts; for I actually passed three carts broken down in these eighteen miles of execrable memory." Young found elsewhere in the North other roads equally bad, where two miles an hour would doubtless have been performed with difficulty.

When the original Government postal system began—with headquarters just out of Eastcheap—the mails between London and Edinburgh took three days. Charles I. having determined in 1635 to mend the dilatory and imperfect communication between the two capitals, established "a running post or two, to run night and day,

between Edinburgh and London, to go thither and come back again in six days." With the downfall of the monarchy this service ended, and in 1649 we find the city of London inaugurating a northern post of its own with a regular staff of runners and postmasters.

The authority of a single postal system managed by the Government was finally settled by an Act passed in 1656. The preamble showed that "the erecting of one General Post Office for the speedy conveying and re-carrying of letters by post to and from all places within England, Scotland and Ireland, and into several parts beyond the seas, hath been and is the best means, not only to maintain a certain and constant intercourse of trade and commerce between all the said places, to the great benefit of the people of these nations, but also to convey the public despatches, and to discover and prevent many dangerous and wicked designs which have been and are daily contrived against the peace and welfare of this Commonwealth, the intelligence whereof cannot well be communicated but by letter of escript."

In 1658 the first stage-coach between London and Edinburgh was put on the road, setting out once a fortnight, and taking nearly that time in transit. The ordinary method of travelling then, and for centuries, was on horseback or on foot. Coaches had been, it is true, introduced in 1553, but they were little used in the country, where, in fact, the fearful condition of the roads would have restricted their use.

In London and all the other large towns the width of the streets prevented the use of

carriages; the Sedan chair, borne by porters, being the polite mode of progression. In Charles I.'s reign horses were occasionally used as bearers, thus forming the earliest idea of the "Hackney coach."

In 1662 there were only six stage-coaches in

THE EARLIEST HACKNEY COACH.

the whole kingdom, and even this number was considered by some of the slow-going conservative citizens as just half-a-dozen too many.

Matters were to be yet worse before they were bettered, for with the establishment of the General Post Office at the Restoration a lower standard of despatch prevailed, and six days, instead of three, were consumed by the mails between London and Edinburgh. Such a retrogression aroused Nottingham, York and other

towns to protest, and as a consequence the King's post became accelerated to "three and a half or four days," which was a rate much slower than that which had prevailed thirty years before. Nevertheless, it must be remembered that the volume of mail business between the two capitals was very scanty, a hint of which truth we may obtain from the fact that, on one occasion in 1745, the mail brought only a single letter from the South—for the British Linen Company. On another day in the same year only one was received in London—for Sir William Pulteney, the banker. With Edinburgh four days from London it was on a par with Constantinople at the present day.

Early in the eighteenth century, when the mails were conveyed on horseback or in light carts, and the robbery of the mail was one of the most common of crimes, the rate of travelling did not often exceed four miles an hour. There is still to be seen a time-bill for the year 1717, addressed "to the several postmasters between London and East Grinstead." It is headed "Haste, haste, post-haste!" from which the casual reader might gather that extraordinary expedition would be observed. The mails, we learn, departed "from the letter-office in London, July 7th, 1717, at half-an-hour past two in the morning," and reached East Grinstead, distant forty-six miles, at half-past three in the afternoon. The rate, including stoppages, was a trifle over four miles an hour. But even in 1766 four miles an hour was regarded as the height of postal celerity. "Letters are conveyed in so short a

time, by night as well as by day, that every twenty-four hours the post goes 120 miles, and in five or six days an answer to a letter may be had from a place 300 miles from London." Letters were despatched from London, as well as received, at all hours of the day and night, there being no regularity in the service until 1784.

As a sample of speed in 1734 we may mention that in that year John Dale advertised that a coach would take the road from Edinburgh for London "towards the end of each week, to be performed in nine days, or three days sooner than any coach on the road." Twenty years later the pace, so far from having improved, was worse, inasmuch as it took ten days in summer and twelve in winter, and in 1763, the coach set out, it is stated, once a month, and "took a fortnight, if the weather was favourable." The cause of this degeneracy is doubtless to be found in the practice of post-chaise travelling in parties —by means of which a few travellers shared a vehicle together and secured greater speed and cheapness. A journey to York was regularly done in four days ("if God permit").

In 1742 the Oxford stage-coach left London at seven in the morning and reached Uxbridge at mid-day. It arrived at High Wycombe at five in the evening, resting there for the night, for there was no travelling in the dark hours, and proceeding on at the same rate on the following day.

In 1758, however, there came an improvement. Up to that year the Great North Mail set out

thrice a week, occupying eighty-seven hours in its northward journey and not less than 131 hours on its return south. The cause of the latter excess was the stoppages made at Berwick and Newcastle, ranging from three hours at the former to twenty-four at the latter. An Edinburgh merchant, George Chalmers, a sufferer by these delays, entered into correspondence with the officials, and after pointing out that the stoppages were quite superfluous, induced them to avoid the old, long route *viâ* Thorne and York for that by Boroughbridge, thereby shortening the journey by twelve miles. This resulted in the time-table being amended, so that the journey was now achieved in eighty-two hours to and eighty-five from Edinburgh. Furthermore, Chalmers prevailed upon the Government to run the mails six times weekly. The Government recognised Chalmers' services by making him a grant of £600.

It was about the same time (1767) that Henry Homer was congratulating his countrymen on the vast improvements which he had witnessed in his lifetime. To the condition of the roads and the difficulties of internal communication he attributed the backward state of the country in the reign of Queen Anne.

The trade of the kingdom languished for means of rapid transit. "Few People," he says, "cared to encounter the Difficulties which attended the Conveyance of Goods from the Places where they were manufactured to the Markets where they were to be disposed of. . . . The Natural Produce of the Country was with Difficulty

THE CABRIOLET.

circulated to supply the Necessities of those Counties and Trading Towns which wanted, and to dispose of the Superfluity of others which abounded. . . . We are now released," he adds, "from treading the cautious steps of our Forefathers and our very Carriages travel with almost winged expedition between every Town of consequence in the Kingdom and the Metropolis. . . . Despatch, which is the very Life and Soul of Business, becomes daily more attainable by the free Circulation opening in every Channel what is adapted to it. . . . There never was a more astonishing Revolution accomplished in the internal System of any Country than has been within the Compass of a few years in that of England. Journies of Business are performed with more than double Expedition. Everything wears the face of Dispatch." In Homer's opinion, it was all due to the "Reformation which has been made in our Publick Roads."

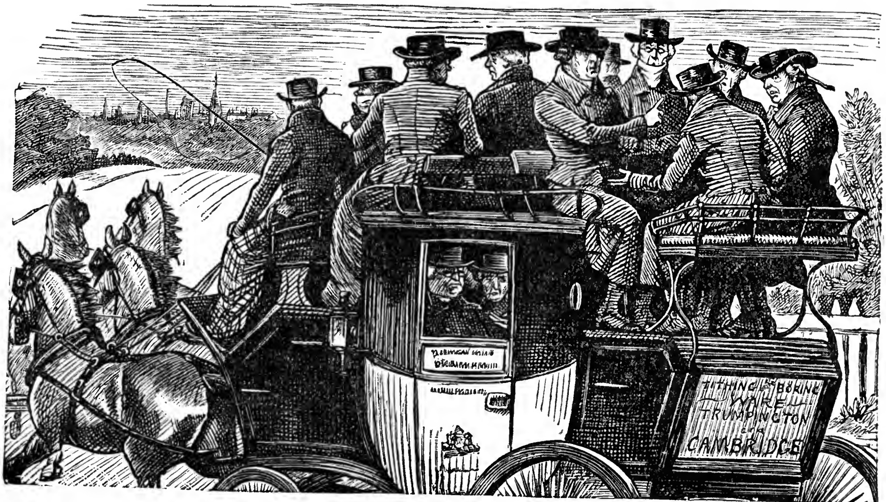
Abroad the roads and means of locomotion were, if anything, behind those of England, the newly-introduced cabriolet being a luxury for the rich, and in the more populous districts travelling was usually done on foot or on horseback in company, as described by Defoe towards the end of his "Robinson Crusoe." The journey from Lisbon to Calais by land took two months in winter and five or six weeks in summer.

While these improvements in land carriages were taking place, attention was also being paid to the provision of facilities for carriage by water. Canals were cut to connect various river

basins, and in 1758 the idea was revived and finally carried out, of connecting the Forth and the Clyde.

In 1758 Brindley had succeeded in carrying out the Duke of Bridgewater's scheme, and this gave a fresh impetus to canal projects. The Duke was the possessor of immense beds of coal at Worsley, which could not be profitably worked owing to the cost of carriage to Manchester. The canal cut down this cost to a fraction and was the beginning of a network of canals which was soon spread over England. It was the Duke of Bridegwater who, when asked his opinion of the new tram-roads, declared that they meant "mischief" to the canal-owners.

For those country gentlemen and citizens of the old school who did not see any virtue in rapid transit a further mortification was at hand. This was the establishment of the mail-coach system by Palmer in 1784. This celebrated advocate of speed had had his attention drawn to the singular discrepancy between the average travelling rate of the post and of the coaches. Letters which left Bath on Monday night were not delivered in London until two or three o'clock in the afternoon of Wednesday, and sometimes even later; yet the coach which left Bath on Monday afternoon arrived in London early enough for the delivery of parcels by ten o'clock the next morning. Despatch was in many cases of such importance to the Bath tradesmen that, although the postage was only threepence, they willingly paid two shillings to forward their letters to the capital in the form of




EARLY STAGE COACH.

a coach parcel. Elsewhere Palmer found the same state of affairs. The post which left London on Monday night or early Tuesday morning, did not reach Warwick, Worcester or Birmingham until Wednesday morning; and the Exeter post not until Thursday morning, while letters were five days in passing from London to Glasgow. It was now proposed to alter all this and establish a regular mail-coach service all over the kingdom, a project which met with the utmost opposition from the authorities, who failed to see "why the post should be the swiftest conveyance in England," and regarded the scheme of bringing the Bristol mail to London in sixteen or eighteen hours as "altogether visionary." Nevertheless, Pitt was resolved to allow Palmer's plan to be put into execution, and the first mail-coach left London for Bristol on the evening of the 24th August 1784. At the end of a dozen years it was found that the greater part of the mails were conveyed in one-half the previous time, in many cases one-third, and in some of the cross-posts in one-fourth of the previous time.

Although it became apparent after the introduction of railways that the days of the mail-coach system were numbered, yet coaches were not entirely superseded on the leading highways for many years. In 1832, according to the London-Edinburgh time-table for that year, the coach left the Post Office at 8 P.M., reached Grantham at 7.23 the following morning, Doncaster at 1.12 P.M., York at 4.54 P.M., Newcastle at 1.50 A.M., and Edinburgh at 2.23 P.M. The whole journey of 397¼ miles was thus made in

forty-two hours twenty-three minutes. The "up" mail was somewhat slower, occupying forty-five hours thirty-nine minutes, but both were equally punctual in arrivals and departures *en route*, so that it has been said that the farmers used to set their clocks and watches by the mail-coaches.

Yet high speed was not yet gained. In 1751 it took twenty-four hours to go from London to Dover: thirty years later it could be done in the course of the same day, and in 1802 Lord Campbell tells us that he started from the "White Bear," Piccadilly, at 4 A.M., reaching Dover at 9 P.M., seventeen hours, including an hour's stoppage for dinner at Canterbury.

Porter, in his "Progress of the Nation," states that he "well remembers leaving the town of Gosport (in 1798) at one o'clock of the morning in the *Telegraph*, then considered a fast coach, and arriving at the Golden Cross, Charing Cross, at eight in the evening; thus occupying nineteen hours in travelling eighty miles, being at the rate of rather more than four miles an hour."

In 1798 the Holyhead mail left London at eight at night and arrived in Shrewsbury between ten and eleven the following night, taking twenty-seven hours to run 162 miles. About this time, too, there was a coach on the road between Shrewsbury and Chester known as the "Shrewsbury and Chester Highflyer." It started from the former town at eight in the morning and arrived at Chester (a distance of forty miles) at the same hour in the evening.

OLD ENGLISH COACH—"THE FLYING COACH.'

## CHAPTER II.

SPEED in locomotion now began to be publicly considered. The performances of the crack mail-coaches were watched with that interest which to-day occasionally attends the journeys of an "ocean greyhound" or an express train to the North.

"It might have been supposed," writes Porter, "that to attain so great a rate of speed as ten miles an hour, the personal safety of passengers would be further endangered, but the very contrary is the fact, so that notwithstanding the rapidity with which we are whirled along, the number of accidents is actually lessened, a result produced by the better construction of the carriages . . . and the superior character of the drivers." *

Sportsmen regarded these achievements as affording them exciting entertainment, but the mercantile part of the community were not slow to perceive that the increased speed had a concern for them. Both classes recognised that better roads were necessary: Parliament became aroused, and Telford and Macadam, by their improved methods of road-making, paved the way, literally, for more rapid locomotion. By the use of broken granite, ashes and burnt clay, hundreds of miles in the kingdom became transformed, and it was not

* "Seated on the old mail-coach," wrote De Quincey, "we needed no evidence out of ourselves to indicate the velocity. We heard our speed, we saw it, we felt it . . . . . . ; and this speed was not the product of blind insensate agencies, that had no sympathy to give, but was incarnated in the fiery eyeballs of the noblest among brutes, in his dilated nostril, spasmodic muscles and thunder-beating hoofs."

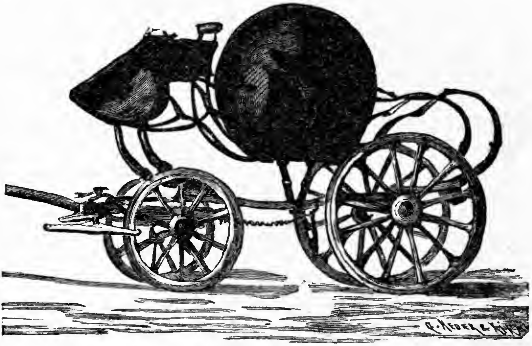
long before it was seen that one horse on a level track could do as much work as four on a common road.

The maximum speed obtainable by the mail-coach on a good road had been reached. When the era of railways dawned there were nearly 3000 stage-coaches in operation—of which number about half plied out of and into London—and about 100 mail-coaches. In his coach system the Englishman took a natural pride, especially upon comparing it with that of France. In no other country was there such promptitude of arrival and departure, or such a volume of transportation traffic.

For instance, the Edinburgh mail ran 400 miles in forty hours, stoppages included, which was at the rate of nearly eleven miles an hour. A coach to Exeter, the *Herald*, went over its ground, 173 miles, in twenty hours, although the country was hilly; and the Devonport mail performed its journey, 227 miles, in twenty-two hours. Of course this increase of speed was considered alarming by those who had been accustomed to the old-fashioned slow coaches, and the speed at which the new vehicles travelled was regarded as a menace to human life.

Nevertheless, there were a body of men crying progress, men like Anderson and Gray, who declared that the commercial future of the country depended upon rapid transit, and that if railroads with steam locomotives were employed it would even be possible to attain a velocity of twenty miles an hour. Upon this proposal the utmost ridicule was cast, especially by the *Quarterly Review*, which assured its readers that the people

"would as soon suffer themselves to be fired off upon one of Congreve's *ricochet* rockets as trust themselves to the mercy of such a machine (a high-pressure engine) and going at such a rate (eighteen or twenty miles an hour)." Criticising the project of the London and Woolwich Railroad, the *Quarterly* backed old Father Thames against it for any sum, and expressed the hope



GLOBULAR-SHAPED MAIL COACH USED ON THE CONTINENT A CENTURY AGO.

that Parliament would "in all railroads it may sanction, limit the speed to eight or nine miles an hour, which is as great as can be ventured upon with safety." Yet at eight or nine miles an hour the cry was still "we move too slowly—unless we can transport our coal and iron—our goods and passengers more quickly, we are giving hostages to fortune and will surely not progress as we ought to progress."

Reflecting upon it now, it seems strange that

so obvious an idea as a tram or railway had not occurred to mankind at an earlier period in its history. It probably did, but mankind was not ready for it: there was nothing to be served by an increase of speed. Apparently, few cared to move quickly; with us in the twentieth century velocity of motion is an end in itself, as witness skating, tobogganing and the switchback railway —to say nothing of cycling and motoring, which do lead us somewhere. It is true Dr Samuel Johnson extolled the delights of post-chaise travelling at the exciting velocity of ten miles an hour; but celerity of movement seems, even sometimes in warfare, to have been an unimportant and therefore unconsidered factor. Napoleon extended the principle of rapid transit to those armies which astonished Europe about the same time that England was bewildered by the news that a journey between London and Edinburgh could be done in less than two days.

The actual inventor of railways is unknown—most probably the idea was contributed to by many. Roger North mentions a sort of wooden tram-line existing in the neighbourhood of Newcastle-on-Tyne prior to 1676. "The manner of the carriage," says he, "is by laying rails of timber from the colliery down to the river exactly straight and parallel; and bulky carts are made with four rowlets fitting these rails, whereby the carriage is so easy that one horse will draw down four or five chaldrons of coal, and is an immense benefit to the coal-merchants."

It was soon discovered that one grave disadvantage attended the use of wood for the con-

struction of the *rails*—its liability to wear. Wherefore, instead of wooden rails, flat iron bars were employed, nailed to the sleepers in the same fashion as the timber rails. This change in construction was found to work well, there being less friction to overcome on the iron than on the wooden rails. In other cases, stone was employed in the construction of these tramways, sometimes to form the rails, but more often the sleepers. A subsequent improvement was made (in 1789) in the iron rails, by forming what is known as an edge rail. The advantage of this was that neither wheel nor rail became clogged with dirt, a condition inseparable from flat rails.

Dr James Anderson late in the eighteenth century recommended the construction of railways for the purpose of conveying agricultural produce from one part of a farm to another. At a later date he proposed the general extension of railways or tram-roads throughout the kingdom. The carriages were of course to be drawn by horses. "Suppose," said he, writing in 1801, long before the introduction of the steam locomotive, "a railway were brought from the wharfs to Bishopsgate Street, . . . all the waggons to be made of one size and form, each capable of containing one ton of sugar, or other goods of similar gravity. Let the body of each of these waggons be put upon a frame that rests upon the two axles of the four wheels, calculated to move only upon the railway, and let each of these waggons be loaded with goods which are to go to the same warehouse or its vicinity. The whole of the waggons being thus loaded, they are moved forward

till they came to the end of the road, at which place they should be made to pass under a crane."

The crane would lift the waggon upon another truck, formed for street use, and when emptied at the close of the day returned to the railway truck which returns to its point of departure. Anderson believed that this methcd of distribution, instead of the old and cumbersome carter system, would result in a great saving of money, time and labour. "The convenience of such roads would be very great from the circumstance of having separate moveable waggons as above stated. One separate waggon or more could be thus left at any place on the road, and others taken up in their stead, like passengers in a stage-coach, without disturbing the others. . . . On the same plan it is certainly very practicable to carry roads of a similar description from London to Bath."

Soon afterwards tram-roads or railways began to spread over the face of the country, more especially in the northern counties, but as yet no one contemplated the employment of tram-cars as a substitute for stage-coaches, until about the era that the locomotive engine was invented. The plan just mentioned of a system of railways, the motive power being horses, was never therefore carried out, although so late as 1830, four years after the opening of the Stockton and Darlington Railway, it was proposed to use horse-power on the London and Birmingham Railway, the vehicles being warranted to travel at the rate of eight miles an hour. In 1801 the Surrey Railway obtained an Act for the construction of

a tram-road for general merchandise from Wandsworth to Croydon, and the line proved a success, one horse being able to pull over fifty tons or fifty times what could be done on an ordinary road.

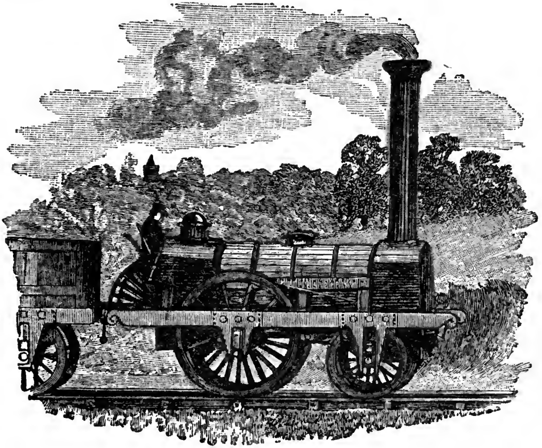
Soon after this time James Gray of Nottingham, visiting one of these tramways which connected the mouth of a colliery with the shipping wharf, exclaimed to the engineer of the line: "Why are not these tram-roads laid down all over England, so as to supersede our common roads, and steam-engines employed to convey goods and passengers along them, so as to supersede horse-power?" The man's answer was, "Just propose that to the nation, sir, and see what you will get by it! Why, sir—you will be worried to death for your pains." Notwithstanding from that moment Gray began to preach the doctrine of tram-roads, locomotives, steam-engines and the superseding of horse-power. "It was his thought by day; it was his dream by night. He talked of it till his friends voted him an intolerable bore. He wrote of it till the reviewers deemed him mad."

Beyond all question the first steam locomotive engine which actually carried passengers on common roads was constructed by an ingenious French mechanic, Nicholas Joseph Cugnot, a native of Lorraine. He was born in 1729, and in his youth served in Germany as a military engineer, publishing several works on military science. After Cugnot's retirement from the army, he was enabled, at the public expense, to build a steam-propelled carriage to run on common roads, which was tried in 1769, in the

presence of a number of illustrious personages. It was mounted upon three wheels, the leading wheel being driven by an engine whose two pistons acted upon it alternately. During its first run Cugnot's machine carried four passengers, and travelled at the rate of two and a quarter miles an hour. Another locomotive from which great things were expected was built in 1770, and made several successful trials in the streets of Paris. Unluckily, the machine had the misfortune to meet with an accident: it capsized at a street corner and was appropriated by the police, who locked it up together with its inventor. Cugnot, however, was quickly released, and long enjoyed a pension from the Government as a reward for his labours.

In this country the first practical idea of applying steam-power to wheeled carriages occurred to Dr Robison, by whom it was communicated to Watt in 1759. Some time subsequently, the latter made a model of a high-pressure locomotive, and described its principle in his fourth patent in 1784, which, among certain improvements, specified "a portable steam-engine and machinery for moving wheel-carriages." His friend, Murdoch, in 1787 made an engine which was employed to drive a small waggon round a room at his house at Redruth, in Cornwall. Amongst those who saw it was Richard Trevethick, who, in 1802, took out a patent for a similar invention. Symington also exhibited a locomotive in Edinburgh in 1787, and eight years later worked a steam-engine on a line of turnpike-road in Lanarkshire and an

adjoining county. The locomotive of Trevethick and Vivian in 1802 ran on the Merthyr tramway, and drew a load of ten tons at the rate of five miles an hour. But one of Trevethick's locomotives blew up—an accident which did much to create distrust of their use.



PASSENGER ENGINE BY STEPHENSON.

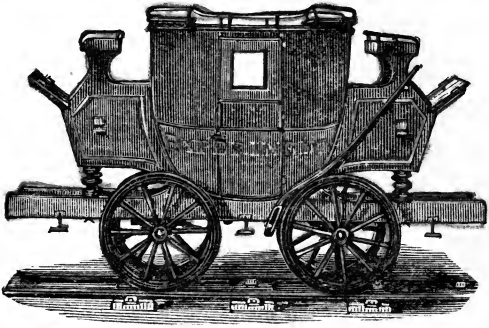
In the meantime George Stephenson was busy at Killingworth verifying the experiments of other inventors and perfecting his own. In 1816 he patented engines that would travel ten miles an hour without a load.

General discontent with the means of intercommunication through the country followed on all this agitation, and rendered commerce restless. When Gray published his "Observations

on a Railroad for the Whole of Europe," in 1820, he said, "Here is the main-spring of the civilization of the world; all distances shall disappear; people will come here from all parts of the continent without danger and without fatigue; distances will be reduced one-half; companies will be formed; immense capital paid and invested; the system shall extend over all countries; emperors, kings and governors, will be its defenders; and this discovery will be put on a par with that of printing."

On the 27th September 1825, a short public railway, sanctioned after repeated delays by Act of Parliament, was opened between Stockton and Darlington, in the county of Durham, a distance of about eleven miles. By the advice of George Stephenson, who had been appointed engineer of the line, iron rails were substituted for wood, and gradually gaining the confidence of the directors, he prevailed upon them to employ instead of horses, such a locomotive engine as he had recently tried, and with success, at Killingworth Colliery. It was intended, of course, solely to transport coal, not passengers. The directors, chiefly Quakers, were ridiculed for their decision. "I am sorry to find," said Lord Eldon, "the intelligent people of the North country gone mad on the subject of railways." Another authority observed that he would undertake to "eat all the coals that your railroad will carry." The farmers were told they would be ruined, as there would be no demand for horses. Nevertheless, the bill was carried, the road was built; and at the appointed hour, in

the presence of a great multitude, "the train moved off at the rate of from ten to twelve miles an hour, with a weight of eighty tons, with one engine—'No. 1'—driven by George Stephenson himself; after it six waggons loaded with coals and flour; then a covered coach, containing directors and proprietors; next twenty-one coal waggons, fitted up for passengers, with which they



THE EXPERIMENT, FIRST RAILWAY PASSENGER COACH, 1825.

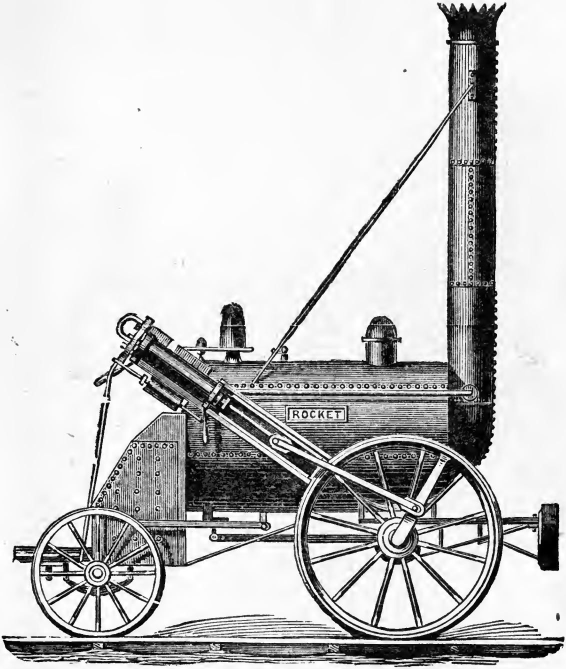
were crammed; and lastly, six more waggons loaded with coals."

The results of the opening of the Stockton and Darlington line were in some respects surprising. Although the conveyance of passengers had formed no part of the original scheme, yet, on the first day, as we have seen, many hundreds of persons made the excursion, and passengers soon insisted upon being taken regularly. It therefore became necessary to provide carriages adapted to their requirements, and thus began the story of the railway passenger traffic of the world.

The Liverpool and Manchester was the first railway of any magnitude that opened its line for the carriage of passengers. It was opened to the public, 15th September 1830, in the presence of the Duke of Wellington and other celebrities, including Mr Huskisson, who lost his life that day as the result of a melancholy accident. Previous to the opening, the directors, in doubt about what form of traction to employ, offered publicly a premium of £500 for the best locomotive that could, under certain stipulations, be constructed. It was required of the competing engines :—

1. That they should consume their own smoke.
2. That if they weighed six tons each they should be capable of drawing a train of twenty tons weight at a speed on the level of ten miles an hour.
3. That each should have two safety-valves—one beyond the control of the engine-driver.
4. That the height of the engine, including chimney, should not exceed fifteen feet: and lastly, that the price of the engine of the successful competitor should not exceed £550 (which was the sum for which Stephenson had built the Stockton and Darlington engine).

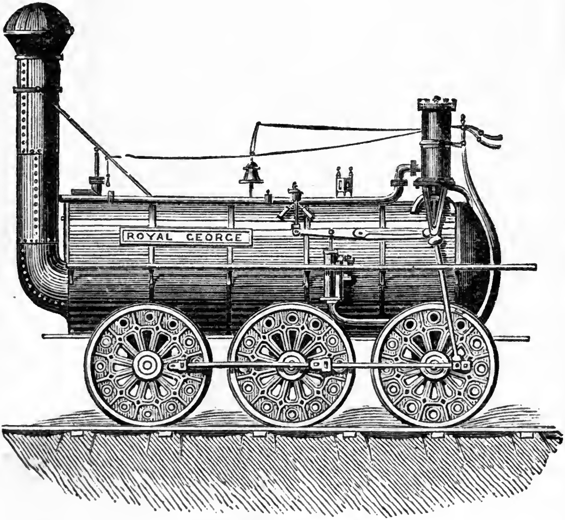
The trial resulted in Stephenson's *Rocket* being declared the winner, the other competitors being the *Novelty* by Braithwaite and Ericson and the *Sans Pareil* by T. Hackworth, both of these, however, suffering unlucky breakdowns. The *Rocket* twice performed the distance of thirty miles: the first time in two hours and a quarter, the second in two hours and seven minutes. Its




THE ROCKET.

greatest speed was at the rate of thirty miles an hour, and the average about fourteen.

From that moment a new era in rapid transit began. No one in Europe had ever travelled thirty miles an hour before except in a balloon.




THE ROYAL GEORGE.

Stephenson was forthwith appointed to build the engines of the railway, and from that period until his death conducted the engineering department of what grew to be the London and North-Western Railway.

On the 15th September 1830 at the grand opening of the line the *Northumbrian*, one of the most powerful of the engines, took the lead, followed by the train of eight locomotives and twenty-eight carriages, which as it rolled proudly onwards, deeply impressed the spectators.* At Parkhurst, seventeen miles from Manchester, a halt was made to replenish the water tanks, when the accident occurred by which Mr Huskisson lost his life, a tragic blot on the day's triumph. On the following day the line was thrown open for business. The *Northumbrian* drew a train with 130 passengers from Liverpool to Manchester in one hour and fifty minutes; and before the close of the week six trains daily were regularly running. The surprise and excitement already created were further increased when one of the locomotives by itself covered the thirty-one miles in less than an hour.

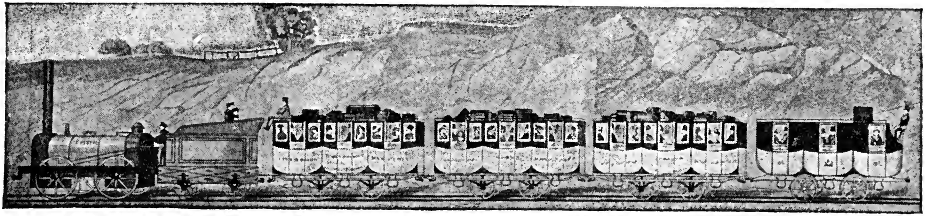
Of the thirty stage-coaches which had plied between the two towns, all save a single one went off the road soon afterwards. The transport of goods and merchandise commenced in December and furnished new occasion for amazement to the public, for a loaded train weighing eighty tons was drawn by the *Planet* engine at from twelve to sixteen miles an hour. In the following February, 1831, the *Samson* achieved a greater feat, conveying 164½ tons

*A local newspaper, describing the event of the opening, when Stephenson himself held the starting lever of the *Northumbrian*, observed, "The engine started off with this immense train of carriages, and such was its velocity that in some parts the speed was frequently twelve miles an hour."

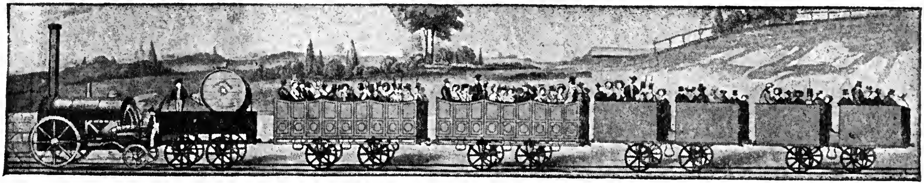
from Liverpool to Manchester in two hours and a half, including stoppages, which would have required seventy horses to perform in twelve hours.

The success of the line rendered obvious the possibilities of the system to the whole world. Branches were soon made to Warrington, to Bolton, and later on a junction was effected to Birmingham. Yet when in 1830 the London and Birmingham Company had sought to obtain their charter, a well-known engineer openly deprecated "the ridiculous expectations or rather professions of the enthusiastic speculator that we shall see engines travelling at the rate of twelve, sixteen, eighteen or twenty miles an hour. Nothing could do more harm towards their general adoption and improvement than the promulgation of such nonsense." The notion that one hundred miles an hour would one day be achieved would probably have driven this faint-hearted champion of rapid transit into paroxysms of derision.

Early in 1838 a Scottish periodical announced that, before the publication of its next number, in consequence of the despatch of the mails to Warrington by the railway, the inhabitants of Edinburgh would receive their letters and papers a whole day sooner, that is to say, in thirty-one instead of fifty-five hours. A return by post between London and Edinburgh, which in 1818 occupied a week, would now be done in three days and a half. The prophecies of disaster on account of the railway were unfulfilled: instead, everything prospered on their account, even



LIVERPOOL AND MANCHESTER RAILWAY—FIRST CLASS, 1830.



LIVERPOOL AND MANCHESTER RAILWAY—SECOND AND THIRD CLASSES, 1831.

the canal proprietors were amazed to find that railway competition improved their profits, instead of declining them. Even horseflesh increased in value, and yet it had been declared that if the railways were to be superseded the stage-coach horses would soon become worthless.

George Stephenson prophesied that it would be cheaper for a working-man to ride by rail than to walk, and the prediction has been literally fulfilled in urban districts. As early as 1844, Parliament enacted that passengers should be carried over all lines with moderate speed and comfort at fares not exceeding 1d. a mile. To these parliamentary trains, as they were called, however, the lowest class of passengers were at first rigidly restricted. The speed may be gauged from the fact that the train from Euston to Liverpool, $201\frac{3}{4}$ miles, started at 7.40 A.M., stopped at every station, and arrived, if punctual, at 6.35 P.M., thus occupying nearly eleven hours on a journey which passengers, paying the same low fare, can now perform in a little over four hours.

## CHAPTER III.

ONCE the art of navigation had been mastered and the regular trade routes established, the matter of speed was allowed to take care of itself, and even in quite modern times the rate at which ships travelled was an arbitrary one and not of a progressive character. Marco Polo in the twelfth century doubtless travelled as fast

as Drake and Raleigh; and the early voyages undertaken by the East India Company to India do not seem to have been materially improved upon by their service in the era of Warren Hastings.*

Rapid transit was occasionally made, even in the old days; and as the eighteenth century wore on and speed came to be more and more considered in commercial circles, regular efforts were made by rival interests to economise time and lessen the number of days and hours *en route.*

But it was not until steam was applied tc navigation that speed became a certainty, and, therefore, a necessity of marine traffic, and it grew possible to establish a regular ocean time-table. Yet to demonstrate that even with sailing-ships our ancestors did not avail themselves of the utmost advantage, there was the memorable annual ocean race of 15,000 miles run by the China tea-ships within living memory. The London tea-brokers, in order to get the new crop into the market as quickly as possible, used to offer a prize of £500 to the officers and crew of the first tea-laden ship which reached the Thames. In 1866 nine such sailing ships left Foochow between May 29th and June 6th, not very long, ranging from 686 to 853 tons register, but all fast, five being Clyde built, three Aberdeen, and one Liverpool. Every yard of canvas was spread, and they were borne swiftly and steadily by the

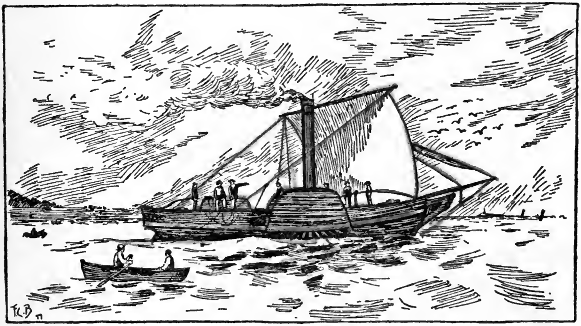
* One voyage, Hastings' return from Calcutta to Plymouth in 1785, was thought remarkable for speed. It was done in four months and a half.

trade-winds across the ocean, sometimes sighting each other on the way. "It was a wonderful race; for the *Teaking*, *Ariel*, and *Serica* all entered the Thames in one day (Sept. 6th), nay, all between 9.45 and 11.30 in the evening, the other six ships being farther from the winning-post." *

It is not necessary here to go into the vexed question as to who invented the steamboat, an honour claimed for several rival inventors in several different countries — nor into the early history of that contrivance. We know that as early as 1783, Fitch, an American, propelled a steamboat on the Delaware river by paddles; but the project was soon abandoned. Five years later Patrick Miller, of Edinburgh, fashioned a steamboat which went at the rate of five miles an hour; and in the following year, in conjunction with Symington, built another steamboat, which attained a speed of seven miles an hour, dragging a heavy load. In 1807, Robert Fulton, who had been personally studying the various experiments in Europe, built a steamer, with engines by Boulton & Watt, which made the voyage *up* the Hudson from New York to Albany, a distance of 150 miles, at the rate of five miles an hour, which was regarded as an astounding feat. The first to make a sea-voyage by steam was Stevens, who went in a new steamer from New York to the Delaware; and having introduced many important improvements, achieved the unheard-of velocity of thirteen miles an hour on that river.

* The course was about 10,000 miles; at the same speed Calcutta would have been reached in eleven weeks.

In Europe the pioneer of steamboats for passenger traffic was Bell's *Comet*, which began to ply regularly between Glasgow and Helensburgh in 1812. In the following year steamers appeared on the Clyde, the Severn and the Thames, and in a few years steam navigation was firmly established, not only in Great Britain but in continental countries.



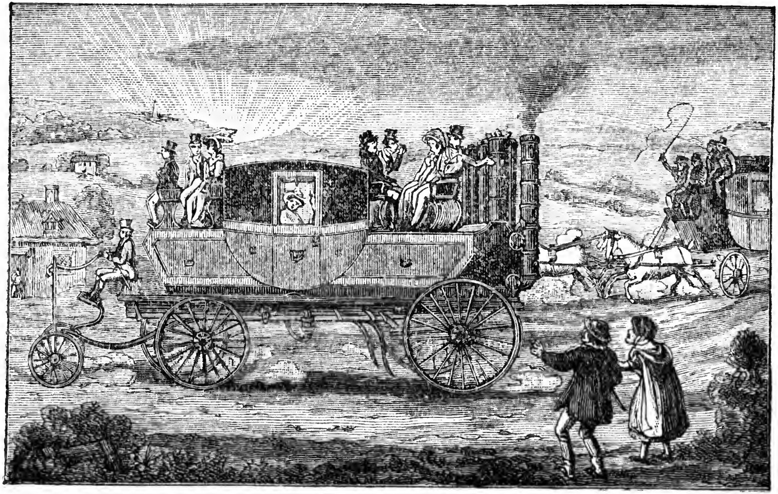
THE "COMET."

The innovation of steam soon entirely revolutionised river and channel traffic. Whereas, before 1813, shipping had been entirely dependent on the wind, it was now possible to travel at the rate of nine miles an hour in a dead calm and seven in moderately boisterous weather, as well as to carry goods and passengers at one-third the charge exacted by land transit. In 1821 they first carried the mails between Dublin and Holyhead and between Calais and Dover.

When it was first proposed to cross the Atlantic

from England solely by steam-power, the project was regarded with suspicion, notwithstanding all that had been thus early accomplished by steam. A number of the most eminent scientific men recorded their opposition to it, and its failure was freely prophesied even by those who believed in the future of land traction by steam. The distance to be traversed was at least 3000 miles of clear ocean, with no intervening land where a vessel might put in for shelter and supplies. It is true that in 1819 a vessel named the *Savannah*, of 350 tons, had made the journey from New York to Liverpool in twenty-six days; but this vessel had used sails as well as steam, and was, besides, a week longer on the voyage than the sailing "liners." The quantity of coal necessary to propel a steamer with engine of 300 horse-power across the Atlantic would, it was estimated, be two tons for each horse-power of the engine—or, say, 700 tons altogether, including provision for accident or delay. There could not possibly be room for so much fuel: if the tonnage of the vessel were made more than four times its horse-power, the latter would be inadequate to its propulsion at the ordinary rate of steam-ships.

The first ship actually to steam across the Atlantic was a Canadian—the *Royal William*, launched at Quebec, 1831, her engines being sent from England. In 1833 she went from Pictou, N.S., to Gravesend, arriving September 11th, after twenty-two days' passage. But this feat attracted little attention, although it no doubt contributed largely to the result so soon to be attained.



STEAM *v.* HORSES.

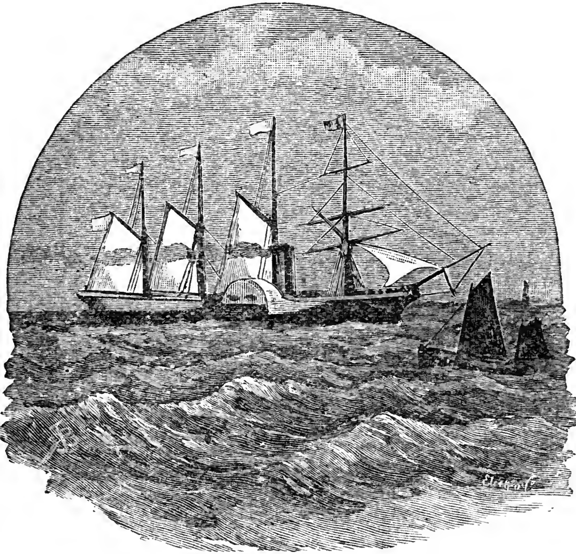
In 1836 there flourished a series of "liners" which accomplished the voyage from New York to London in about twenty days, but owing to the Atlantic currents this time was usually increased to thirty-six days on the voyage from London to New York. Mercantile considerations demanded an improvement in the speed of communication between the Old World and the New.

If the regular navigation of the Atlantic by steam were practicable, it was essential to national interests that it should forthwith be adopted. Nothing is so important in extensive commercial transactions as early and regular intelligence and a quick and speedy transmission of orders and goods. From what steamers had already done, it was urged reasonable to expect that they would cross the Atlantic in half the time occupied by the old liners. New York would therefore be brought within a ten or fourteen days' voyage from London, Bristol, or Liverpool. Moreover the arrival of advices could be circulated with certainty to a day, if not to an hour—and the effect of this certainty and punctuality would have a widespread influence in every department of trade.

The *Great Western*, a steamship of 1200 tons, which was to make the experiment, left Bristol on the 8th of April 1838 for New York, having on board 660 tons of coal and seven adventurous passengers.

Three days before, the owners of the *Sirius*, a much smaller vessel, built to ply between London

and Cork, had despatched her for the same destination. Thus there ensued a struggle of two steamers, which should be the first to traverse



THE "GREAT WESTERN."

the entire breadth of the wild Atlantic. The *Sirius*, which had the start by some days and 400 miles, made little way comparatively the first week. She carried more weight in proportion than the *Great Western*; but as her coals were consumed, she made much better running. For

instance, during the first week out, her daily run never exceeded 136 miles; on the second day indeed it was only 89. On the other hand the *Great Western* accomplished ten miles an hour during the second day, and her average daily run for the whole voyage was 211 miles. At this rate she would soon overtake her rival; but as the *Sirius* got lighter she made greater speed. On the fourteenth day she ran 218 miles, equalling the *Great Western*, and on the twenty-second ran only three miles less than her larger competitor.

But although it was a close race, the *Sirius*, by reason of her start, was the winner, arriving in New York on the morning of the 23rd. The *Great Western* steamed in the same afternoon amidst the greatest excitement—flags flying, guns firing, and bells ringing.

Ten to fifteen days had thus been knocked off the westward Atlantic journey. Never before had a voyage to the New World been done in fifteen days. The first, by Columbus, had taken five weeks.*

The *Sirius* proved too small for continued Atlantic navigation, and was soon withdrawn to follow her original route between Cork and London, and was afterwards lost off the Irish coast. But the *Great Western* continued to ply regularly and successfully, making in the course of the next six years thirty-five voyages. The average distance steamed each voyage was nearly

* *i.e.* from the Canaries to St Kitts. The probable distance run between Gomera and the newly-discovered island was 3105 miles, an average of 105 miles in thirty-five days. The longest daily run was 200 miles.

3500 miles; the average time occupied in going to New York was fifteen days, twelve hours, and in returning, thirteen days, nine hours.

In 1845 the *Great Britain* reduced the time of the voyage nearly one day to New York, but in the meantime the record time for crossing the Atlantic had been achieved by a Canadian, in a ship the same size as the *Great Western.* In 1838, closely following upon the success of the latter ship and the *Sirius*, the Government advertised for tenders for carrying the ocean mails. Eventually it was arranged that Samuel Cunard of Halifax, Nova Scotia, should receive £65,000 per annum for seven years for conveying the mails twice each month between Liverpool, Halifax, Quebec and Boston. In pursuance of this contract, the steamer *Britannia* left Liverpool 4th July 1840, and arrived at Halifax in twelve days ten hours, the voyage home being performed in ten days.

This was the foundation of the famous Cunard Line. The speed and regularity with which the mails were carried evoked general admiration. The vessels were looked for and usually arrived on the appointed day, and a journey which was made with daring and just apprehensions a few decades back was soon reduced to a brief episode lasting from nine to eleven days.

In 1849 the average length of passage from Liverpool to Halifax was 11 days, 3 hours; from Halifax to Liverpool, 9 days, 21 hours; Halifax to Boston, 34 hours; Halifax to New York, 55 hours; New York to Halifax, 62 hours; and Boston to Halifax, 41 hours. These returns

show a marked increase in speed over the early voyages of steamers across the Atlantic.

But still although the transit across the ocean had been rendered more rapid, the time of the voyage between Liverpool and New York had not been materially reduced.

The steamers of the Cunard Line were, however, soon to have competitors. Soon after they began to ply direct to the American commercial capital a fleet of five American steamers, one after another, appeared to contest with them the "blue ribbon of the Atlantic." The first ship of the Collins Line, called the *Atlantic*, sailed from New York on the 27th April 1850. As the time of her expected arrival at Liverpool drew near, the public interest became intense, and it was realised that a rivalry had begun which would make of the ocean a gigantic race-course for the ships of the two nations. But "the prizes of the turf are paltry compared with that for which these steamers contended—the proud distinction of establishing the most speedy and safe communication between two great continents and two mighty nations!"

At length when the steamers of the Cunard Line began to ply direct to the American commercial capital the rate of speed began to increase. With the splendid new ships which were built every appliance which could ensure speed was tried. In 1862, by the *Scotia*, then the fastest and largest of the Atlantic fleet, the run from New York to Liverpool was made within nine days.

This feat was regarded as the acme of speed

in ocean travelling. "Faster than this," wrote one great authority, "it would be neither safe or desirable to go—if, indeed, such velocity ever became possible."

The superiority, however, was not distinctly shown by either side. The fastest western passage in 1850 was made by the *Pacific* in September, when only ten days, five hours were consumed between Liverpool and New York; while the swiftest eastern voyage was that of the *Asia* in ten and a half days.

In the meantime, the screw principle had been developed, the *Propeller*, which entered the Mersey in 1840, being the first large steamer to dispense entirely with side paddles, and not long afterwards all the vessels of the Inman Line were equipped with screws. After the failure of the Collins Line, this company obtained the mail contract between Liverpool and New York.

On 16th August 1825, the steamer *Enterprise* left Falmouth for Calcutta. She arrived at the Cape on 13th October, and at Calcutta 9th December, having been nearly four months on the voyage, which was about the usual time of a sailing vessel. This was found unsatisfactory: but although shorter routes to India could be found, there was none which was to be entirely traversed by a single vessel. The expedient was therefore resolved upon to break the voyage in half—and have it performed by two sets of steamers. At the eastern extremity of the Mediterranean a steamship would be within a few miles of a sea which formed an unbroken water route to the Far East. The obstacle was

the Isthmus of Suez. Several experiments were undertaken by the Government, and in 1837 the route *via* Alexandria, Cairo and Suez, comprising a land transit of eighty-four miles, was adopted. The British Government undertook the transportation between England and Egypt, and the East India Company between Egypt and India. The mails were sent from Falmouth to Gibraltar in vessels engaged in the postal service with Portugal and Spain; at Gibraltar they were transferred to Admiralty steamers which conveyed them to Malta and Alexandria; they were then carried up the Nile to Cairo, and from thence across the desert to Suez, where a steamer belonging to the East India Company was in waiting to convey them to Bombay.

The time occupied by the old all-sea route was one hundred days; communication with India *via* Suez was now reduced to between fifty and sixty days.

Even yet the community was not satisfied. In order to reduce this time still further, a treaty was made in 1839 with the French Government to convey a portion of the mails through France to Marseilles, from whence they were forwarded to Malta, where the steamer from Gibraltar was met. By this expedient two more days were saved.

Prior to 1837, the mails between Falmouth and Gibraltar took from eighteen to twenty-one days in transit, the vessels calling at Vigo, Oporto, Lisbon and Cadiz. In that year the Government entered into a contract with the "Peninsula Steam Company," and soon their

steamers were conveying the mails in five days. Desiring still further to accelerate the mail service to India, a further arrangement was made in 1840 with this company to run from England to Alexandria, calling only at Gibraltar and Malta, and by this means communication to Suez was made almost as rapid as through France.

When, in the course of two or three years, the transit to Suez was rendered swift and regular, it was natural that communication on the other side of the isthmus should be extended and accelerated. A contract was therefore made with the Company—known thereafter as the "Peninsular and Oriental"—by which Calcutta, Madras, Ceylon and China were embraced within the scope of the service. The latter was commenced in 1845 with three steamers, the *Bentinck, Hindustan* and *Precursor*, of about 2000 tons and 500 horse-power. Ocean steaming was so far developed in 1850 that mails were delivered at Hong-Kong containing letters which only fifty-five days before had been written at New York. This performance, which so astounded our sires, and was even a matter of wonderment in the early 'seventies, is rendered more significant when we remember that these letters after crossing the Atlantic had passed through Liverpool, London, Paris, Marseilles, Malta, Alexandria and Cairo to Suez, where they were placed on board the P. and O. steamer, which bore them down the Red Sea and across the Indian Ocean to Ceylon, where they were transferred to another steamer and by her conveyed, after calling at Penang and Singapore, to their ultimate destination. The whole journey

was equal in length to half the circumference of the globe.*

In 1851 the steamers for Alexandria sailed from Southampton on the 20th of each month, arrived at Gibraltar on the 26th, at Malta on the 1st of the following month, and at Alexandria on the 9th. A small steamer conveyed passengers and mails up the Nile and in vans across the desert (the railway not being built at that time). On the 10th the steamer left Suez, steaming down the Red Sea to Aden. Calcutta was reached in about twenty-eight days from Suez—or seven weeks from Southampton.

But although this velocity caused the utmost admiration throughout Europe, the next few years were to bring about great further changes and improvement. Many important circumstances were to influence and expand the Eastern traffic, principal among which was the assumption by the Imperial Government of the powers of the East India Company; the growth of a gigantic trade with the free ports of China and Japan; the great increase of import and export trade consequent on the Australian gold discoveries; the reduction of letter-postage and the establishment of book-post; healthy steamship competition and the construction of a railway across the isthmus from Alexandria to Suez.

In 1866 the P. and O. Company were bound by contract to convey the mails between Southampton and Alexandria in 310 hours; Marseilles

* Even now the journey to Hong-Kong consumes forty days by the all-sea route. To Bombay it takes but fifteen days.

and Alexandria, 155 hours; Suez to Calcutta, 499 hours; Bombay to Hong-Kong, 413 hours; Hong-Kong to Shanghai, 84 hours; and Suez and Bombay, 312 hours. A few hours' grace was allowed in each case, but anything beyond twenty-four hours involved a forfeit of £50 a day; whereas, to anticipate the delivery of the mails entitled them to a premium of £25 a day.

Thus we see that the voyage by sea from Southampton to Alexandria had been reduced from nineteen days in 1850 to less than thirteen days in 1866; while from Suez to Calcutta could now be done in just under three weeks. By travelling by rail, however, to Marseilles (thirty-two hours), Alexandria could be reached in six days, eleven hours from Marseilles.

Then in 1871 came the Mont Cenis Tunnel, which placed unbroken communication by rail at the disposal of France and Italy. This resulted in the despatch of mails over-land to Brindisi, and thence conveyed by steamers to Alexandria.

The great advantage of the Suez Canal is the enormous decrease in the distance to be travelled between Europe and India, and consequent enormous saving of time. It is about 10,719 miles from London or Hamburg, by the Cape of Good Hope, to Bombay. By the Suez Canal this was reduced to 6274. From Marseilles to Bombay *via* the Cape, the distance is 10,560 miles; by Suez it is only 4620.

And the passage through the Suez Canal itself has been materially cut down. The average transit in 1886 was fifty-four hours. Now, by the aid

of electric light, navigation is continued throughout the night, and the average passage of steamers is just under seventeen hours. The width of the canal in the straight parts is 213 feet. No ship is allowed to exceed five or six knots an hour; so that if the canal were wider the hundred miles could be done in less than half the time.

The value of the British possessions in the West Indies and the importance of the South American trade foreshadowed the establishment of speedy communication in that quarter. Prior to 1840 the best sailing vessels took four weeks to Barbados and Demerara, although the distance was only about 4000 miles in a direct line. By the establishment of the Royal Mail Steam-Packet Company in the above-mentioned year, a fleet of fourteen steamers were built to sail twice every month to the West Indies, St Thomas being the chief rendezvous. The run from Southampton to St Thomas was done regularly in eighteen days. Ten years later this was cut down to fifteen days.

In 1865 the Royal Mail steamer left Southampton on 9th of each month, got to Lisbon on 14th, St Vincent (Cape Verde) on the 22nd, crossed the Atlantic, reached Pernambuco on the 30th; thence to Bahia on the 2nd of the following month, to Rio de Janeiro on the 5th—twenty-six days after leaving England. At Rio a branch steamer was ready to convey the mails farther south, arriving at Monte Video on the 14th, to Buenos Ayres on the 15th. This journey to Rio has since been cut down to seventeen days, and Monte Video can be reached in twenty-one days.

The quickest journeys to South America are made by the Hamburg-Amerika Line, which, after leaving Lisbon, sails direct to Rio without calling at any intermediate ports. Rio is reached fourteen days after leaving Southampton, and Buenos Aires in eighteen days.

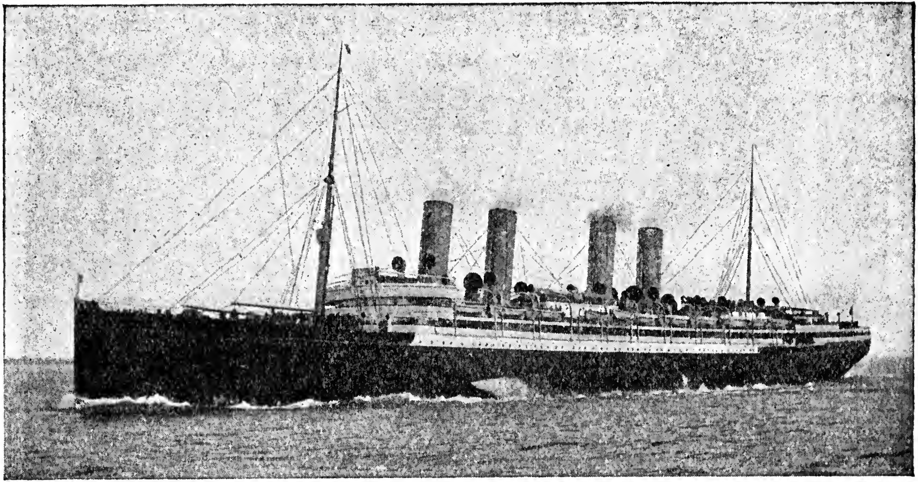
The subsequent general adoption of the surface-condenser and the circular multi-tubular boiler enabled higher pressures of steam to be safely carried and economically employed. By 1877, we may say, steamers had been established on all the longer routes and worked at high rates of speed. In that year the Orient Steam Navigation Company began a series of fortnightly sailings to Australia, one of their steamers, the *Orient*, astonishing the world by making the passage from Plymouth to Adelaide, *via* Suez Canal, in thirty-five days, sixteen hours, and the same voyage *via* the Cape, in thirty-four days, one hour steaming time. It was when the Australian liner *Aberdeen* was built in 1881 that the merits of the triple-expansion type of engine, now so universal, were first conclusively shown. The engines of this vessel worked with a boiler pressure of 125 lbs. per square inch, and expansion took place in three cylinders. Her first voyage from Plymouth to Melbourne occupied forty-two days. In 1883 a New Zealand line was instituted, and voyages from England thence cut down from sixty-five to thirty-seven or forty days.

But it was and is on the Atlantic that the greatest ocean speed triumphs have been won. In 1874 the White Star liners *Britannic* and

*Germanic* were built at Belfast, and from that year re-began a hotly-waged contest for superiority in speed, size and equipment which has lasted to the present day. Each increase in speed now-a-days represents innumerable modifications—some minor, some radical—which engineering and shipbuilding science suggests. For a time the White Star liners maintained first place for speed, until they were ousted by the Inman liner *City of Berlin*, which beat the *Britannic's* record of eight and a quarter days across the Atlantic. Liner after liner appeared, each faster than its predecessor, until in 1886 the average time between Sandy Hook and Queenstown was about six days, fifteen hours, as compared with eleven days, nineteen hours in 1856. Since then the record has been lowered repeatedly. The *Campania* achieved the journey in five days, twelve hours, fifteen minutes, which was supposed to be unsurpassable until it was broken first by one ocean greyhound and then another, the *Lucania* in 1894 doing the voyage in five days, eight hours from Queenstown to New York.

The *Lucania's* record of 562 knots in a single day was soon to be beaten by the great North German Lloyd steamers sailing from Southampton to New York, one of which, the *Fürst Bismarck*, had already done this longer journey in less than six and a half days.

In July 1901, the *Deutschland* lowered all records by crossing the Atlantic in five days, eleven hours, five minutes, her average speed being 23·51 knots, whilst the best day's run was 557 miles. The distance traversed between



THE "DEUTSCHLAND."

Sandy Hook and the Eddystone on that occasion was 3082 miles. In June 1902 the *Kronprinz Wilhelm* maintained a trifle higher average speed than the *Deutschland's* record. As a matter of fact, the length of the voyage between New York and Plymouth was not reduced, as the *Kronprinz* was five days, eleven hours, thirty-two minutes running between Sandy Hook and the Eddystone, twenty-seven minutes longer than the *Deutschland*, but in those few minutes she steamed an additional thirteen miles, the log of the *Kronprinz* showing that the total distance travelled was 3095 miles. Thus, although the *Kronprinz* established a new record for average speed, the *Deutschland's* 557 miles remained the best day's run on the homeward voyage. The *Kronprinz's* average speed throughout her trip was 23·53 knots.

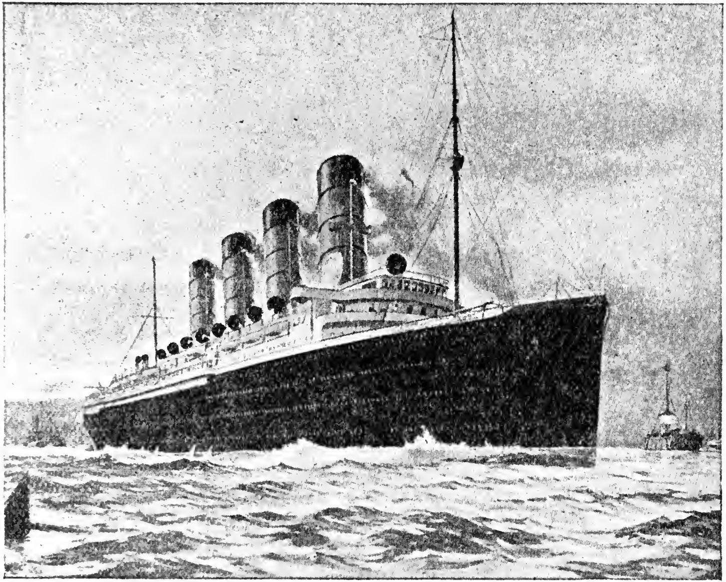
In 1901 the new twin-screw steamer *Arundel*, made a record Channel passage from New Haven to Dieppe in two hours, fifty-eight minutes, or at an average speed of twenty-two knots. The absence of all vibration was secured to passengers by a patent balancing arrangement of the machinery.

What part electric traction will play in the future of steam navigation cannot easily be predicted. But even with steam, it is almost certain that the old piston and cylinder type of engine will be superseded. Another and fundamentally different type—the turbine—in which the impulse of the steam spins a wheel instead of pushing a piston—is making great headway. The antiquity of the idea is considerable—it is even ascribed to Hero of Alexandria, who

describes an elementary form of such an engine, and this rotary principle was certainly experimented with and abandoned by the seventeenth century experimenters. The reason was that it was not adapted to pumping, this being the end then, and until towards the close of the eighteenth century, in view. In the meantime the piston-engine became developed, and the turbine principle rested dormant until only some twenty years ago the requirements of the dynamo-electric machine opened up fresh inducements for development. By 1894 so many details had been worked out, that capital was induced to venture upon the construction of an experimental ship. This vessel, the *Turbinia*, after repeated trials and modifications achieved the unprecedented speed of $34\frac{1}{2}$ knots an hour. This was the high-water mark of marine travelling—but it was to be surpassed. The *Viper*, a larger but similar vessel, constructed for the Navy, as a torpedo-destroyer, reached a velocity of forty-one miles an hour. The builder has stated his confidence that fifty and even sixty miles an hour will yet be achieved by such craft on the high seas.

Turbine engines were soon adopted on many cross Channel steamers, and were found to give greater speed for the same horse-power, with much less vibration than before. At the same time, coal consumption, engine room staff, and weight of machinery were reduced. It is therefore not surprising that turbines are now being used to drive ships of all sizes.

The first ocean liner to be fitted with turbines



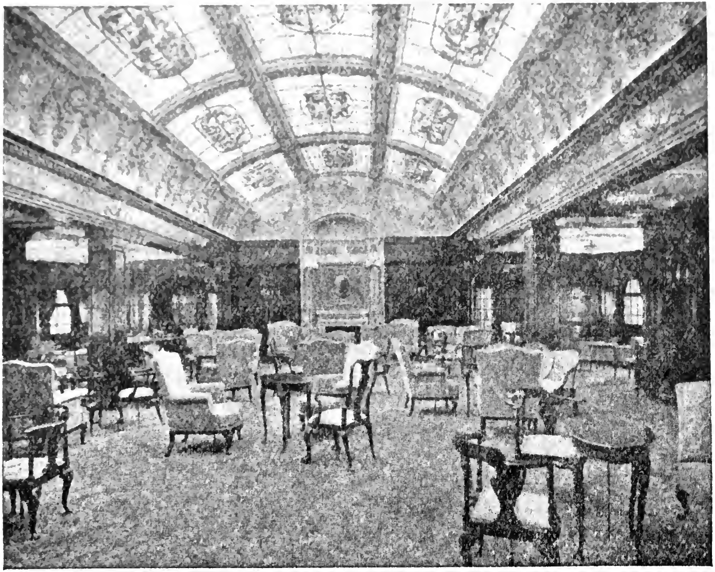
R.M.S. "MAURETANIA."

was the Allan liner *Victorian* in 1904. In 1907 came the Cunard vessels the *Lusitania* and *Mauretania*, which quickly lowered all previous Atlantic records. The *Mauretania* in 1909 accomplished the journey from Queenstown to Sandy Hook in the remarkably short time of four days, ten hours, forty-one minutes—a record which has not at present been surpassed. Her average speed on this journey was 26·06 knots an hour, and her longest day's run was 676 knots.

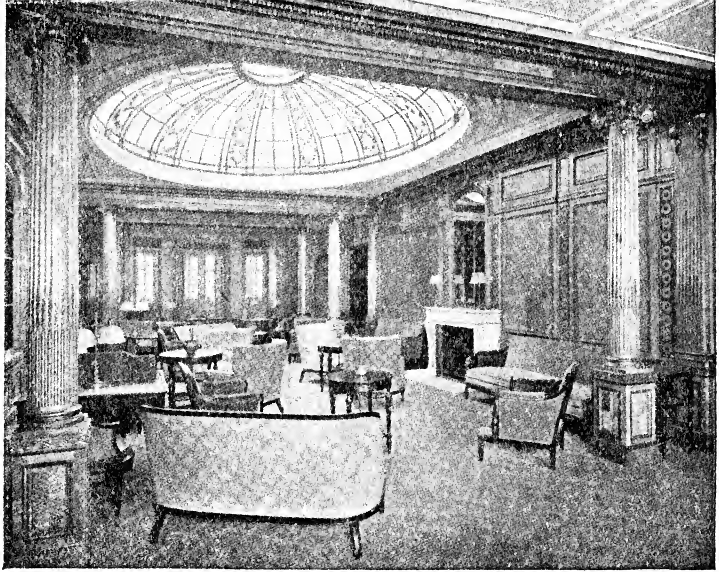
The mammoth liner, of the Hamburg-Amerika Line, the *Imperator*, now nearing completion, is fitted with four turbine engines having a total of 72,000 horse-power, and capable of developing an average speed of 22½ knots an hour. One of the immense rotors, containing 50,000 blades, weighs 135 tons, and develops over 22,000 horse-power. The casing enclosing the rotors is 25 feet long and 18 feet in diameter. The shafts are 1½ feet, and the four propellers 16 feet, in diameter.

The *Imperator*, which is the first of three sister ships, is the largest steamer ever built. She has a displacement of 50,000 tons, and her length is 919 feet. In length she will be beaten by the *Aquitania*, the latest steamer of the Cunard Line, which will be almost 1000 feet long. Her displacement will be 45,000 tons, the same as that of the ill-fated *Titanic*.

For the present, at least, the commercial contest has been abandoned, and no further attempts at record breaking are being made. It is possible also that the commercial limit of size has been almost reached. The huge



THE LUXURY OF OCEAN TRAVEL—THE LOUNGE ON THE "LUSITANIA."



THE "MAURETANIA'S" WRITING-ROOM AND LIBRARY.

vessels now being constructed are designed not with a view to higher speeds, but to provide greater carrying capacity and greater comfort for passengers. Ball-rooms, theatres, verandahs, and winter gardens, restaurants, cafés and tea gardens, render these modern floating palaces as comfortable as the most luxurious hotel ever erected on land.

It may well be that the year 1911 will prove to have marked the beginning of a new era in ocean travel, for in that year the first commercial oil-driven vessel crossed the Atlantic. For many years engineers have been working at the problem of the application of the internal combustion engine to ocean-going vessels on a large scale, and the results of their labours are now becoming apparent. The first motor vessel to cross the Atlantic was the *Toiler*, a twin-screw vessel built at Wallsend. She is fitted with Diesel engines (constructed at Stockholm) of 1000 horse-power, and consumes crude oil. It is claimed that the oil consumption is under two tons per day, whereas steam engines of the same power would require from eight to nine tons of coal. Several similar vessels are under construction.

In 1912 some much larger oil-driven craft were produced. The *Jutlandia*, a vessel of some 5000 tons displacement, built on the Clyde, is 370 feet in length, and is fitted with engines of 2500 horse-power. The machinery in these motor vessels occupies only about one-third of the space of boilers and steam engines, thus leaving far more room for the stowage of cargo and

for the use of passengers. When, in addition to this, the saving in fuel cost is remembered, the future before this type of vessel is readily realised.

A novel form of sea-going cargo vessel was also launched in 1911, the *Holzapfel I.* She is fitted with gas engines and gas-producing plant. The fuel consumed is said to be half the amount that would have been required had she been fitted with steam engines.

Compared with the leviathans of the ocean to which the traveller of to-day is accustomed, these oil-fuel vessels may seem indeed trifling. Nevertheless, their importance cannot be over-estimated, indicating as they do the rapid advent of the age of petrol. There is little doubt that these slow-going cargo steamers, making their ten or eleven knots an hour, are but the forerunners of the motor liner, which will equal, if not surpass, the finest performances of the present day.

## CHAPTER IV.

It was to be expected that foreign countries would eagerly avail themselves of the extraordinary advantages which railways had been shown to confer upon commerce and society.

But the neighbouring kingdom of France was

very backward. English visitors to that country in 1845 were wont to complain of the slow pace of the *diligence*, not remembering that it was quite equal to that which at the beginning of the century was ordinarily accomplished in England.

Posting in Germany was soon, after the downfall of Napoleon, placed on a much improved footing in the matter of speed: but even in 1840 from fourteen to eighteen German miles was reckoned as the ordinary extent of a day's journey.

"France," observes a writer in 1844, "has allowed herself to be outstripped by her neighbours, not only by England, but also by Belgium, Prussia and Austria, in these means of extending national resources and civilization, which the country more especially stands in need of. She has, however, for the present laid out her money in fortifications, and has little to spare for lines of communication. This, however, is not the sole reason; it lies in the want of confidence between man and man, and in the absence of the spirit of association, by means of which all great public works are executed in England, by private enterprise, but which does not exist in France." Yet even at this time the use of steam in navigation was very general in France, all the great rivers being traversed by steamers. "In almost all cases," we read, "the engineers employed on these vessels are Englishmen."

Railway progress in France was certainly slow, and for some years lagged behind England, Belgium and Germany. Although the intro-

duction of the first tram-road dates from 1783, it was not until 1835 that the first modern railway was begun by the authorisation of the line from Paris to St Germains, its completion following two years later. In 1838 the Orleans line was undertaken, and the railway from Paris to Rouen was opened in May 1843 and soon afterwards extended to Havre. Comprehensive measures at last followed on the part of the Government, which proposed to form railways from the capital to all the frontiers of France, taking the principal towns and cities *en route.* By 1865 the plan was practically carried out, and between 8000 and 9000 miles were open for traffic.

In Belgium, preparations for railways began in 1834, and thirty years later the network was nearly as close and intricate as in Great Britain. Germany early permitted railways to cross her frontiers, and soon numerous lines were stretching far and wide throughout the Empire. Iron highways also began to be projected and built in Italy and Russia, Holland, Sweden and the other European states. In Spain in 1851 there were only two railways, one of eighteen miles from Barcelona to Mataro; another forty-five miles, from Madrid to Aranjuez. It took some time to conquer the national aversion to rapid transit, and journeys were still made throughout the Peninsula at the speed with which the immortal Gil Blas travelled from Madrid to Alcantara.

The first line in Spain was inaugurated with the ceremony of "blessing the engine" by the Cardinal Archbishop of Toledo, in presence

A DILIGENCE.

of the Court, Cortès, distinguished nobles, troops and halberdiers and three miles of spectators. The following day the peasants on the road, seeing the trains travelling at the unheard-of velocity of fifteen miles an hour, involuntarily fell on their knees and crossed themselves until the monster was out of sight. This speed was not, however, regularly maintained; twelve miles an hour was for a long time the standard schedule time on the Spanish railways.

But let us return to England just before the general employment of railways.

In 1837 it was necessary in order to proceed to Dover by the most expeditious public conveyance to book seats in the "Foreign Mail" which left the General Post Office in St Martin's le Grand every Tuesday and Friday night, and arrived in Dover in time for the packets at 8.15 the following morning — thus beating by half an hour any other coach on the road.

For day travel, the *Express* started from the "Golden Cross," Charing Cross, at 10 A.M. each morning, doing the journey in nine hours, as did the "Union Coach." The others took longer. The famous *Tally-ho* coach between London and Canterbury, left town every afternoon and accomplished the fifty-nine miles in five hours and a half.

Laws were actually passed in England, on the first introduction of steam on railways, limiting the pressure in the engine-boilers to 30 lbs. per square inch. The first railroad charter contained a clause limiting the speed of trains to twelve

# Great Western Railway.

## LONDON TO MAIDENHEAD.

a d 1839

**On and after the 1st of May, the SOUTHALL STATION will be opened**
*For Passengers and Parcels.*

**An Extra Train to Slough** will leave Paddington on **Sunday Mornings,** at **half-past 9 o'clock,** calling at Ealing, Hanwell, Southall and West Drayton.

**Horses and Carriages,** being at the Paddington or Maidenhead Station ten minutes before the departure of a Train, will be conveyed upon this Railway.

*Charge for 4-wheel Carriage,* 12s. *Two-wheel ditto,* 8s. *For 1 Horse,* 10s. *Pair of Horses,* 16s.

**Post Horses** are kept in readiness both at Paddington and Maidenhead, and upon sufficient notice being given at Paddington, or at the Bull and Mouth Office, St. Martin's-le-Grand, would be sent to bring Carriages from any part of London to the station, at a moderate charge.

### TRAINS.

**From Paddington To Maidenhead.**

8 o'clock morn. calling at - - Southall and Slough
9 do. - - - Slough
10 do. - West Drayton and Slough
12 do. - West Drayton and Slough
2 o'clock afternoon - West Drayton and Slough
4 do. - - - Slough
5 do. - - Hanwell and Slough
6 o'clock evening Ealing, West Drayton and Slough
7 do. - - Southall and Slough
8 do. - - - Slough

**From Maidenhead To Paddington.**

6 o'clock morning, calling at - - Slough
(and on Wednesday Morning at Southall)
8 do. - Slough and West Drayton
9 do. - Slough and West Drayton
10 do. - - Slough and Southall
12 do. - Slough and West Drayton
2 o'clock afternoon - - Slough and Southall
4 do. - - - Slough
5 do. - - Slough and Hanwell
6 o'clock evening - Slough and West Drayton
7 do. - - Slough and Ealing

**The six o'clock up Train will call at Southall on Wednesday mornings, for the convenience of persons attending the market on that day.**

### SHORT TRAINS.

**From Paddington To West Drayton.**

¼ past 9 o'Clock Morning,
¼ past 1 do. Afternoon,
¼ past 4 do. do.
¼ past 8 do. Evening
calling at **Ealing, Hanwell, AND Southall,**

**From West Drayton To Paddington.**

¼ before 9 o'Clock Morning,
¼ before 11 do.
¼ before 3 Afternoon
¼ before 7 o'Clock Evening
calling at **Southall, Hanwell, AND Ealing.**

☞ *There are no second class close carriages in the short Trains.*

Passengers and Parcels for Slough and Maidenhead will be conveyed from all the stations by means of the short Trains, waiting to be taken on by the succeeding long Train, as above; and in like manner they will be conveyed from Maidenhead and Slough, to every station on the Line.

### On SUNDAYS.

**From Paddington To Maidenhead.**

8 o'clock Morn. calling at - - Ealing and Slough
½ past 8 do. do. - West Drayton and Slough
9 do. do. - - Southall and Slough
5 afternoon do. Hanwell West Drayton and Slough
6 evening do. Ealing West Drayton and Slough
7 do. do. - - Southall and Slough

**From Maidenhead To Paddington.**

6 o'clock morn. calling at - - - - - Slough
8 do. do. - Slough Southall and Ealing
9 do. do. Slough West Drayton and Hanwell
5 afternoon do. - - - Slough and Hanwell
6 evening do. - - Slough and West Drayton
7 do. do. - - - Slough and Ealing

### SHORT TRAINS,

**PADDINGTON TO SLOUGH.**

**Half-past Nine o'Clock Morning,** - - - **calling at Ealing, Hanwell, Southall, and Drayton.**

**To West Drayton.**

¼ past 9 o'Clock Morning, calling at *Ealing, Hanwell, & Southall, and proceeding to Slough*
¼ past 8 do. Evening, *Ealing, Hanwell & Southall*

**From West Drayton.**

¼ before 8 o'Clock Morning,
¼ before 7 do. Evening,
calling at *Southall, Hanwell & Ealing.*

### FARES.

| Paddington. | 1st. Class. Coach. s. | d. | Second Class. Close. s. | d. | Open. s. | d. | Maidenhead. | 1st. Class. Coach. s. | d. | Second Class. Close. s. | d. | Open. s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *To Ealing* ..... | 1 | 6 | 1 | 0 | 0 | 9 | *To Slough* ..... | 2 | 0 | 1 | 6 | 1 | 0 |
| *Hanwell* ... | 2 | 0 | 1 | 6 | 1 | 0 | *West Drayton* | 3 | 0 | 2 | 6 | 2 | 0 |
| *Southall* .... | 2 | 6 | 1 | 9 | 1 | 3 | *Southall* .... | 4 | 0 | 3 | 0 | 2 | 6 |
| *West Drayton* | 3 | 6 | 2 | 0 | 1 | 6 | *Hanwell* ... | 4 | 6 | 3 | 6 | 3 | 0 |
| *Slough* ..... | 4 | 6 | 3 | 0 | 2 | 6 | *Ealing* ..... | 5 | 0 | 4 | 0 | 3 | 6 |
| *Maidenhead.* | 5 | 6 | 4 | 0 | 3 | 6 | *Paddington.* | 5 | 6 | 4 | 0 | 3 | 6 |

*The same Fares will be charged from Slough to West Drayton as from Maidenhead to Slough.*

Omnibuses and Coaches start from Princes Street, Bank, one hour before the departure of each Train, calling at the Angel Inn, Islington; Bull Inn, Holborn; Moore's Green Man and Still, Oxford Street; Golden Cross, Charing Cross; Chaplin's Universal Office, Regent Circus; and Gloucester Warehouse, Oxford Street; to the Paddington station.—**Fare 6d.** without

FACSIMILE TIME-TABLE, 1839.

miles an hour, and when thirty miles an hour was suggested, it was ridiculed as an idea simply insane. "Such a fearful velocity would, without doubt, have the most disastrous effects upon the circulation of the blood and the vital organs."

We have seen what was the time consumed between London and Paris: let us now glance at the conditions which obtained in 1843 by the chief routes:—

By Dover and Calais.

| | Miles. | Hours. |
|---|---|---|
| London to Dover (by railway) . | 88 | 3½* |
| Dover to Calais (by steamer) . | 25 | 3 |
| Calais to Paris (by diligence) . | 178 | 23 |
| Total . | 291 | 29½ |

By another route, *via* Brighton and Dieppe, the journey to the French capital was made as follows:—

| | Miles. | Hours. |
|---|---|---|
| London to Brighton . . . | 50½ | 2 |
| Brighton to Shoreham . . | 5 | 0¼ |
| Shoreham to Havre . . . | 94 | 9 |
| Havre to Paris . . . . | 132 | 13 |
| Total . | 281½ | 24¼ |

When in 1839 the Midland Counties Railway was opened the only modes of conveyance were the canal, the fly-waggon and the coach. Only three of the latter ran daily each way between

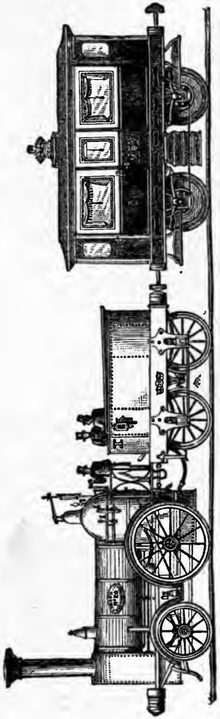
* In 1842 it is given in "Murray's Guide" as five hours.

Leicester and Nottingham. A wool-stapler stated at the time that he frequently had from twenty to five hundred bags of wool lying at Bristol which could not be brought forward by land, and he had therefore to divide the bulk and send it by different routes; the part despatched by the road taking from a week to ten days in transit, and that by water from three weeks to a month. So great were the difficulties at Plymouth that goods had usually to come by sea to London.

Yet in the early days of railways great speed was attained on special occasions. Mr Allport has recalled that in 1845, before the era of telegraphs, when "the battle of the gauges" (*i.e.* between the broad gauge and the narrow gauge system) "was being vigorously carried on, I wished to show what the narrow gauge could do. The election of George Hudson as member for Sunderland had that day taken place, and I availed myself of the event to see how quickly I could get the information up to London, have it printed in the *Times* newspaper, and brought back to Sunderland. The election was over at four o'clock in the afternoon, and by about five o'clock the returns of the voting for every half hour during the poll were collected from the different booths, and copies were handed to me. I had ordered a service of trains to be in readiness for the journey, and I at once started from Sunderland to York; another train was in waiting at York to take me to Normington, and others in their turn to Derby, to Rugby, to Wolverton and to Euston. Thence I drove to the *Times* office and handed my manuscript to Mr Delane, who, according to an

arrangement I had previously made with him, had it immediately set up in type, a leader written, both inserted, and a lot of impressions taken. Two hours were thus spent in London, and then I set off on my return journey and arrived in Sunderland next morning at about ten o'clock, before the announcement of the poll. I there handed over copies I had brought with me of that day's *Times* newspaper, containing the returns of what had happened in Sunderland the afternoon before. Between five o'clock in the evening and ten that morning I had travelled 600 miles, besides spending two hours in London,—a clear run of forty miles an hour."

It was at this period of the railway mania that one express steamed up to London, 118 miles, in an hour and a half, nearly eighty miles an hour.



THE ROYAL TRAIN IN 1843, LONDON AND BIRMINGHAM.

In 1846 the distance between London and Exeter ($193\frac{3}{4}$ miles) was regularly accomplished in four hours and a half. In the same year the

distance between London and Liverpool (210 miles) occupied just six hours.

In 1842 the Great Western Railway caused some interesting experiments to be made with regard to speed. On one occasion an expert driver ran his train over the eighteen miles between London and Slough in fifteen minutes, which was at that time the maximum speed which had ever been attained on a railway. Six years later the fifty-three miles between London and Didcot were traversed in forty-seven minutes.

For many years the reputation of being the fastest train in the world was enjoyed by the "Flying Dutchman." The distance between London and Swindon, seventy-eight miles, was regularly done in one hour and twenty-seven minutes, which was at the rate of fifty-three miles an hour. In 1880, Exeter, 194 miles, was reached in four and a quarter hours, or at an average pace, including stoppages, of forty-five and a half miles an hour.

Compare this schedule travelling by established routes, with the seven hours from London to Swindon in 1830, or the twenty hours from London to Exeter, at the same epoch, of the fast mail-coach.

Since the journey between London and Manchester had been cut down to four and a half hours, twenty-five years elapsed before it was found possible to diminish it. In 1885, however, the three great lines had twelve expresses, each accomplishing the distance in four and a quarter hours, on some portions of the road over sixty

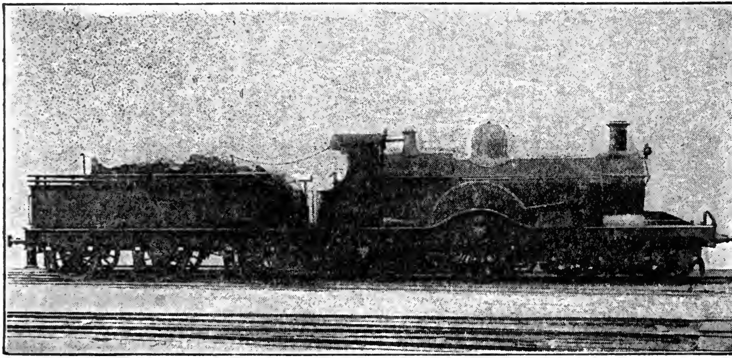
miles an hour being made.* Between Crewe and Rugby, seventy-five and a quarter miles were covered in one hour and thirty-seven minutes. From Manchester to Sheffield is forty-one miles, and this journey is regularly done in fifty-nine minutes, including a twenty mile gradient and a three mile tunnel. It became possible at about the same time for a resident at Grantham to travel to London, 105 miles, in one hour and fifty-five minutes, a journey which would have taken his grandfather eleven hours to accomplish by the best mail-coach on the road. It is now done in one hour fifty minutes—an average speed of $57\frac{1}{2}$ miles per hour.

London and Birmingham are now brought within two hours of each other. This is a saving of a full half-hour over the time for 1901.

The journey from London to Edinburgh has from time immemorial been regarded as the criterion of rapid travelling in these islands. We have seen that the high-water mark of the Edinburgh mail in 1820 was forty hours, stoppages included. To-day one may complete the journey of 395 miles, *via* the Great Northern Railway, in seven hours forty-five minutes. From London to Leicester (100 miles) is now regularly done in 105 minutes; from Leeds to London (186 miles) in three hours twenty-five minutes, and London to Brighton (51 miles) in sixty minutes.

To the Midland Railway is due the credit of first running third class carriages by all trains. Up to March 1872 progress for the ordinary

* The duration of the journey has now been curtailed to three and a half hours.



GREAT WESTERN RAILWAY, "THE FLYING DUTCHMAN."

passenger was provokingly and scandalously slow. Not only was the average speed scarcely more than fifteen miles an hour, but the traveller was forced to start at an uncomfortably early hour to catch the only train that ran. The reform was hailed with joy all over the kingdom. "When," observed Mr Allport, "the rich man travels, or if he lies abed all day, his capital remains undiminished and perhaps his income flows in all the same. But when a poor man travels he has not only to pay his fare, but to sink his capital, for his time is his capital; and if he now consumes only five hours instead of ten in making a journey, he has saved five hours of time for useful labour—useful to himself, to his family and to society." The change, which had taken twenty-five years to bring about, resulted in enhancing the passenger traffic of the kingdom four-fold.

If we wish to obtain an idea of the speed to which railway trains were brought in less than fifty years after their introduction, we have only to compare it with the velocity of a cannon ball. According to the investigations of Dr Hutton, the flight of a cannon ball, with a range of 6700 feet, takes a quarter of a minute, or at the rate of five miles a minute, or 300 miles an hour. Hence it follows that a railway train moving at seventy-five miles an hour has one-fourth of the velocity of a cannon ball—moving at 100 miles an hour it has one-third that velocity. It may therefore be considered as a huge projectile, subject to the same laws which govern projectiles, but weighing 100 tons instead of 100 pounds.

When a train is running at fifty miles an hour, the pistons are working along the cylinders at the rate of 800 feet a minute. When running at seventy miles an hour, the pace of the train is at the rate of 105 feet per second, so that if two trains pass one another, each going at this speed, they would flash past each other in a single second, even if one were seventy yards long.

Nine-tenths of the fast or express trains in England reach the standard of "thirty miles an hour, including stops" (or a journey speed of forty miles an hour), and the other tenth fall short only because their journey is exceptionally hilly, or exceptionally brief, or subject to delay. The above regulation test, therefore, for any train wishing to be called "express" in England is not an artificial one, but a natural definition supplied by the companies themselves on their daily time-tables.*

Considerably more force has to be expended to attain this speed than would appear at first sight. "Imagine a train shot suddenly out from its starting point at forty miles an hour, maintaining with unflagging uniformity this same high speed uphill, through suburbs and junctions, persisting this pace without a moment's pause for two or three hundred miles till it come to an instantaneous stop at its distant terminus; the mildest of the trains we call 'express' will arrive as soon as this imaginary one, though our actual train has had to labour slowly up the hills, to slack for bridges, curves or junctions, besides consuming precious time in four or five stoppages

* E. Foxwell, "Express Trains."

of as many minutes each. The feeblest 'express' is as smart as this; what then shall we say of trains which secure an 'inclusive speed' of nearly fifty miles an hour over summits of 1000 feet?"

The Great Northern Railway has the shortest route to Leeds, Bradford, York and Edinburgh, being seven miles shorter to the latter city than the North-Western, and fourteen shorter than the Midland route. Its rolling stock is among the best in the kingdom, and some of its achievements between London and Liverpool and London and Edinburgh exhibit a very high rate of speed. The daily run from Grantham to London, which, as has already been mentioned, is accomplished at an average speed of 57·5 miles per hour, is the second best long distance run (counting only journeys of 100 miles and over) in the country.

An interesting contrast, showing the progress made during the last forty years, is provided by the photograph reproduced as a frontispiece. The enormous increase of size and power of the Great Northern Railway Company's locomotives as built in 1872 and 1912 (which is but typical of the increase which has taken place on all our large railways) is well shown. These powerful present-day engines are necessary to maintain high speeds with the heavy trains now in use.

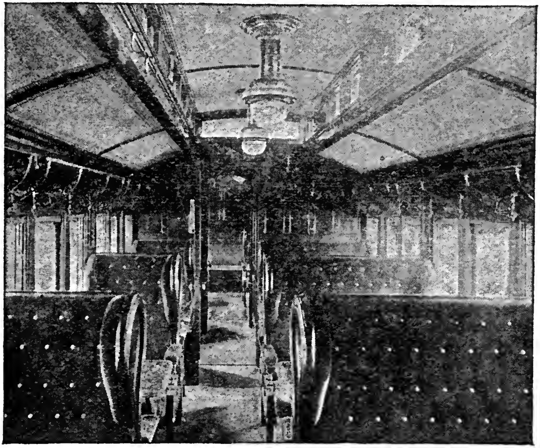
In the summer of 1888 the three great lines which start from Euston, St Pancras and King's Cross resolved upon an attempt to beat their own record to Edinburgh. The best long run made up to that time was that achieved by a special train on the Great Northern Railway in July 1880. It was conveying the Lord Mayor

of London to Scarborough. The distance from London to York, 188 miles, was accomplished in 217 minutes, which implied an average, including a ten minutes' stoppage at Grantham, of fifty-two miles an hour. The first fifty-three miles from London were done in an hour, not ten miles of the road being level. Stoke, 100 miles, was passed in one hour and fifty-one minutes; while between Barkstone and Tuxford, twenty-two and a quarter miles, the speed was at the rate of sixty-four miles an hour. At that period, the ordinary express trains of the line occupied three hours and forty-eight minutes—or eleven minutes more on the journey.

In August took place the first of the exciting races to Edinburgh, when the daily performance of each of the rival expresses was wired in detail to the newspapers. The origin of the competition was the action of the Great Northern Railway in announcing some months before that it would carry third-class passengers in its night express to Edinburgh and Glasgow, which took nine hours to the former city and ten hours twenty minutes to the latter. This was throwing down the gauntlet to the North-Western, inasmuch as it was in the one case nearly an hour quicker than that Company's best third class express.

By the new arrangement, therefore, third-class passengers could arrive in Edinburgh one hour sooner by the Great Northern line. The *doyen* of railways quickly responded by lowering its time to nine hours between Glasgow and Edinburgh and Euston. In addition, a new express was put on for Perth, leaving Euston at

10.30 and arriving in Perth at 9.35, twenty minutes quicker than before. Admirers of speed were delighted at these evidences of youthful enterprise on the part of an old established line up to then content to work its trains at a velocity less brilliant than either of its two rivals.



INTERIOR OF A THIRD-CLASS DINING CAR, MIDLAND RAILWAY.

Early in June, the response of the Great Northern came. It gave notice that it intended forthwith to shorten its Edinburgh and Glasgow journeys by half-an-hour both ways, making the time for Edinburgh eight and a half hours, and for Glasgow nine hours fifty minutes. The interested public were also informed that the

Midland line intended to lop a whole hour off their fastest time to Glasgow, and twenty-five minutes off that to Edinburgh, thus doing the former journey in nine hours twenty minutes (twenty minutes longer than the North-Western, whose route is twenty miles shorter) and Edinburgh in nine and three-quarter hours.

But the North-Western was not to be beaten: it felt its prestige at stake and abruptly gave three days' notice that from August 1st they too would run to Edinburgh in eight and a half hours. This sudden move at the eleventh hour seemed to render it impossible for the other road to arrange reprisals in time to secure the bulk of the holiday traffic. Nevertheless, the Great Northern in a few hours issued its working notices all over the line announcing that from August 1st by their route the journey to Scotland would be done in *eight* hours. The third competing railway, recognising the futility of further long distance rivalry, fell out of the running and kept to their previous programme. The last days of July were a stirring experience for the "Office of the Superintendent of the Line" at King's Cross and Euston. The urgent introduction of such extraordinary "accelerations" as these, involving special "shunts" and signal-box instructions all along the line the whole length of the route, demanded the utmost coolness and executive skill—especially as the "accelerations" were wrought in the very busiest week of the railway year. An alarmist cry of "Danger" went up from certain newspapers and excitable individuals, and all sorts of

horrors were wildly predicted, as a result of this velocity.

During the first week the North-Western, finding they ran over Shap summit easily in the shortest time (at fifty-one and a half miles an hour), and the Caledonian still more easily (fifty miles an hour), gave notice that they would equal the speed of the Great Northern. Yet every day the rival expresses ran with the time, the West Coast train, on the opening day, actually saving fifteen minutes on the road, arriving at Edinburgh at 5.52. The ninety miles from Preston to Carlisle, a steep incline, was done in eighty-nine minutes. As the rival line had also been running under time, it decided that its express should arrive in the Scotch capital at 5.45, or seven and three-quarter hours, from London. The North-Western cheerfully followed suit, and got into Edinburgh in seven hours thirty-eight minutes. The Great Northern then did the journey in seven hours thirty-two minutes, and with that achievement the contest suddenly came to an end. Negotiations took place and a compromise was effected, the West Coast relapsing to its previous programme of eight hours, while the East Coast, being eight miles shorter, was permitted to make the transit in seven and three-quarter hours. But although "racing" ceased, phenomenal speed was maintained to the end of the month, and on the 28th August the East Coast express reached Edinburgh at 5.29, three minutes sooner than the best previous records. The North-Western responded with a farewell performance, beating

this record by one minute in spite of the longer distance. On one day of this race of 1888, Crewe to Preston (fifty-one miles) was done in fifty minutes; Preston to Carlisle (ninety miles) in eighty-nine minutes; Carlisle to Edinburgh ($100\frac{3}{4}$ miles) in $102\frac{1}{2}$ minutes; and Newcastle to Edinburgh (124 miles) in 124 minutes. So smooth was the motion that the unsuspecting passengers were unaware they were taking part in a feat that, on level ground, would have been without a precedent.

The "race to the North" was resumed by the rival railways in 1895. In June of that year the best trains between London and Aberdeen took eleven hours thirty-five minutes by the East Coast route (523 miles), and eleven hours fifty minutes by the West Coast (540 miles). From July 1st the latter accelerated their time by ten minutes, and their rivals taking this as a challenge, immediately lowered their time by twenty minutes. The West Coast responded a fortnight later by an acceleration of forty minutes, and a pitched battle ensued, raging fiercely for a month. Although the West Coast maintained the lead in arrival at Aberdeen almost throughout, yet allowing for stoppages, weight of train, &c., there was not much to choose between the two competitors. On August 22nd, the 8 P.M. train from Euston reached Aberdeen at 4.32 A.M., an acceleration of no less than three hours eighteen minutes on its speed before the racing began. This meant an average of 63·3 miles an hour including stoppages. The expense, if not the risk, of

these high pressure speeds led to an agreement, and the rivalry suddenly ceased. Nevertheless, the September *Bradshaw* showed that ten and a half hours would be the future time between London and Aberdeen, a saving of more than one hour on the old time, besides a considerable improvement in the speed to Inverness, Perth, Glasgow and Edinburgh. Moreover, the contest restored to this country the record for daily long distance fast travelling, which for three previous years had been held by the Empire State Express, which runs from New York to Buffalo (440 miles) in eight hours forty minutes. This now became beaten both by the West Coast time to Perth (450 miles) in eight hours forty minutes, and by the East Coast time to Dundee (452 miles) in eight hours forty-seven minutes.

As a rejoinder, on September 11th the New York Central Railway ran a racing train from New York to Buffalo, which performed the journey in six hours fifty-one minutes, an average speed (including stoppages) of 64·22 miles an hour!

Another important acceleration of railway speed brought about in 1895 was on the Great Western Railway between London and Bristol, Bath and the west of England generally. It was accomplished by the purchase of the Swindon Junction Hotel property, which was held by its owners under an extraordinary agreement which made it obligatory to stop all passenger trains passing through Swindon, ten minutes for refreshments. This ridiculous arrangement dated from 1841 and was for ninety-nine years. In

order to annul it the Great Western Company had to pay no less than £100,000.

Since the "race to Edinburgh" of 1888, there had been an understanding that neither of the rival companies should time their day trains quicker than eight and a half hours. Twelve years later, however, in November 1900, the East Coast route announced that thereafter it would accelerate its "Flying Scotsman" so as to do the journey in eight and a quarter hours. The West Coast Company did the same. It was believed that the first-named company were extremely desirous of winning back to Great Britain the record for railway speed which in the interval had again passed first to America and then to France. For the title of the fastest train in the world, once belonging to the "Flying Scotsman," was in 1900 bestowed upon the "Sud Express" of the Orleans Company, which averaged fifty-four miles an hour, including stoppages, for a journey of 486 miles. But this rate of speed is a remarkable exception for France.

The accepted definition of an English or American express train is one whose speed, inclusive of stops, is at least forty miles an hour. This figure, we are told, exhibits the relative efficiency and energy of the traffic administration, while the "running average," as it is called, may show a much higher degree of speed, excluding the stops.

Very few Continental express trains attain a journey speed of forty miles an hour, the average being considerably less. In 1888 the distance between Paris and Brindisi, 1182 miles, took

forty-three hours, which, fast as it would have seemed to our grandfathers, was yet only an average of twenty-six miles, or no faster than such ships as the *Umbria*, *Etruria* and *Deutschland* travelled on the Atlantic.

The St Gothard Tunnel was begun in 1872 and finished in 1880; it measures nine and a quarter miles in length, is twenty-six feet wide and twenty-one high, and cost £2,270,000 to build. In connection with the railway, which climbs up the lower slopes of the St Gothard and descends on the other side, it is possible to cross the Alps from Lucerne to Bellinzona, 105 miles, in three and a half hours; fifty years ago it required twenty-three hours.

In America, the country perhaps where time and speed are most prized in the affairs of life, rapid transit has within the last twenty years grown to be universal, at least in the eastern states, and in the cities. Urban and local transit forms a feature of itself, but in the speed of the ordinary railways it is only during the last twenty years that the American lines have equalled those of Great Britain.

In the old days it took a whole day, with relays of horses, to travel from Baltimore to Washington, a distance of only forty miles; when railways were introduced it was accomplished in two hours; in President Lincoln's time it was done in a little over an hour. It now regularly takes forty-five minutes, and has been done in less.

The ninety miles between New York and Philadelphia is now covered in ninety minutes.

The journey to Chicago, 909 miles, recently took less than eighteen hours, by one line; and although sixty miles longer by another route was accomplished in the same time, at an average speed for nearly 1000 miles of 54·6 miles an hour. Both lines now take 20 hours. Chicago to San Francisco takes seventy-two and a half hours, and to cross the entire continent from New York four days eighteen hours.

A few years ago the journey of fifty-five and a half miles from Philadelphia (Camden) to Atlantic City was accomplished in fifty minutes—a speed of 66·6 miles an hour. At the present time the fastest running in the United States is made between New York and Albany (143 miles) at 53·6 miles per hour. The long journey of 439½ miles between New York City and Buffalo is performed at the rate of 53·2 miles an hour.

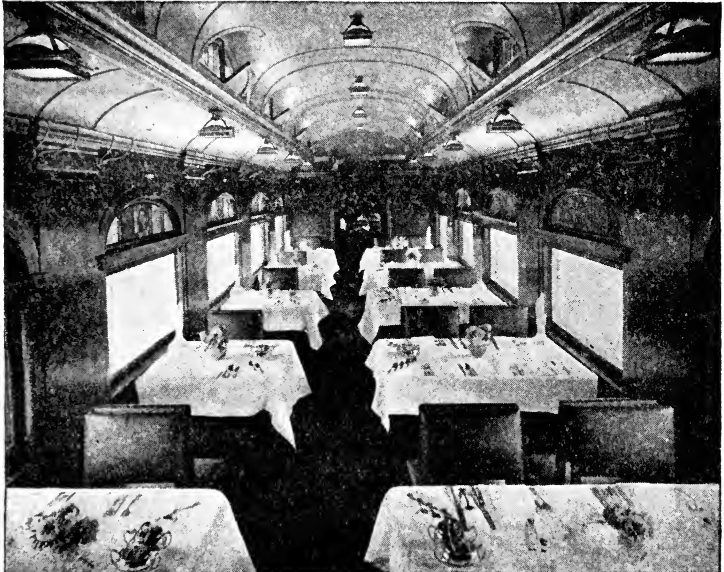
The longest non-stop run in Great Britain is made by the Great Western Railway between London and Plymouth. The distance of 226 miles is traversed at an average of fifty-five miles per hour. In 1903 a Royal special train performed this journey at an average of sixty-three miles an hour.

The quickest service now regularly running in this country is on the North-Eastern Railway from Darlington to York, a distance of 44½ miles, the average speed being as high as 61·6 miles an hour. Almost as good is the speed of 61·3 miles an hour attained daily by the Great Central Railway on the short distance of only 22½ miles between Leicester and Nottingham. Considering

the large proportion of the journey which must be occupied getting up speed and slowing down, this is an excellent performance. The next highest speed is made by a much heavier train than those just referred to, on the Great Western Railway between Paddington and Bath. The distance is 107 miles, and the time occupied one hour forty-eight minutes, which gives an average of 59·4 miles an hour. This is the quickest long distance run in the world. Foreign long distance times are also beaten by the Great Central Railway, which runs from Marylebone to Leicester at an average of 57·8 miles an hour over the whole distance of 107½ miles.

This long distance speed record, which originally belonged to the United Kingdom during the London to Edinburgh contests, was for a time held by France with a run of 120 miles from Paris to Arras in 117 minutes—an average of 61·5 miles an hour. The fastest train in France at the present time runs from Paris to St Quentin. The distance is ninety-five miles, and the time taken ninety-five minutes. Germany's best speed is fifty-five miles an hour—the rate at which the distance of 101 miles between Berlin and Halle is traversed by the expresses of the Prussian State Railway.

In 1891, on the Canadian Pacific line, a special train conveyed the Japanese mail from Vancouver to Brockville, Ont. (2800 miles), in seventy-seven hours, or a speed of thirty-six miles an hour for the whole of this vast run. On the Grand Trunk Railway of Canada the best service is provided by the "International Limited,"



INTERIOR OF DINING CAR ON THE GRAND TRUNK RAILWAY OF CANADA.

which is said to be "Canada's finest train." It runs from Montreal to Chicago, a distance of 840 miles, in twenty-two hours, which gives an average of 38·2 miles per hour. In Australia, from Melbourne to Sydney is run at thirty-four miles an hour, including stops, and over thirty-seven excluding stops. The best run in Australia is from Parramatta to Penrith, a distance of twenty miles, which is covered in twenty-five minutes, equivalent to a speed of forty-eight miles an hour.

When, some fifty years ago, Jules Verne wrote his entertaining romance, "Around the World in Eighty Days," he was thought to have exceeded all bounds of possibility: at that time the circumnavigation of the globe had never been accomplished in less time than 121 days. In 1873 it was done in 109 days. Eventually, an American performed the feat in ninety days, and in 1891 a Miss Bisland lowered the time to seventy-two days. The opening of the Trans-Siberian Railway has removed many of the difficulties that formerly had to be overcome, and has considerably reduced the time required.

Eastern Siberia, which a few years ago was one of the most remote districts on the face of the globe, is now almost as accessible as Canada. The connection between Russia and Siberia forms the greatest railway scheme in the world. The first sod was cut at Vladivostock, May 24, 1891; and to facilitate the work of construction the line was divided into three parts. Even in the incomplete state of the line, by means of the lakes and rivers, uninterrupted steam communication between the railway system of Europe and

Vladivostock on the Pacific was rendered possible in 1901. From Cheliabinsk, the first station in Western Siberia, to Stretensk, *via* Omsk, Tomsk and Irkutsk, is a distance of 2762 miles. This section of the journey comprises the passage of Lake Baikal, just beyond the Irkutsk. When the line was first opened special ice-breaker ferries were built capable of transporting a complete railway train across the lake, the train continuing its journey from the eastern side of the lake to Stretensk, which is still the terminus of the Siberian Railway. From thence a steamer travelled up the Amur river a distance of 1443 miles to Khabarovsk, which was already connected to Vladivostock by 485 miles of railway, opened in 1898. The entire journey then took seventeen days, and from Paris to Vladivostock was timed at twenty-four and a half days.

The railway round the south end of Lake Baikal was completed in 1905, but the extension from Stretensk to Khabarovsk, as originally intended, was abandoned in consequence of the prohibitive cost. Instead, a line has been made branching off from Karimskaia (about 150 miles before Stretensk) to Kharbine (the junction for Dalni and Peking), and on to Vladivostock. This section of the Trans-Siberian Railway, which is properly the Eastern Chinese Railway, is about 1300 miles in length. The whole distance from Cheliabinsk to Vladivostock is 4028 miles; from Moscow, 5393 miles; and from St Petersburg, 5797 miles.

A weekly service of through trains is maintained by the International Sleeping Car Com-

pany between Moscow and Vladivostock. These trains are composed of first and second class cars, containing compartments for two and four passengers. The first class compartments contain two sleeping berths; also table, chair, special reading lamp, and ample hook and rack accommodation for hand baggage. A separate lavatory (with hot and cold water) is provided for every two compartments communicating; there are also lavatories at each end of the car. On the Russian State and Chinese Eastern Company's trains there are no lavatories between the compartments.

The *personnel* of the trains generally speak four languages—Russian, German, English and French. On the Chinese portion of the journey the attendants speak Chinese and Russian. The restaurant cars contain a library with illustrated papers and games—dominoes, chess, etc. Of the conductors, one is a trained nurse, and arrangements can be made for a doctor to visit the train during its stoppage at the principal stations. A medicine chest is carried on each train. Little more could be done to provide for the comfort of passengers on this long and tedious journey.

The traveller leaves London at 9 a.m. on Monday, joins the Nord express at Brussels, and by Wednesday evening finds himself at Moscow. The same evening he leaves in the through Trans-Siberian train. Ten days later, or thirteen days after leaving London, he arrives in Vladivostock or Peking. One day more suffices to take him to Japan or Hong Kong. In 1804 the journey from London to Peking took twenty-nine weeks.

Berlin and London are now, for the first time, within nineteen hours of each other. The traveller who leaves the German capital a few minutes after one o'clock embarks at Flushing the same evening, spends a comfortable night on a well-equipped steamer, and lands at Folkestone early the following morning. Before 8 A.M. he finds himself in London, ready to commence his day's work, having breakfasted on the train.

The journey from Berlin to St Petersburg, 1028 miles, takes twenty-eight and a half hours, or an average of thirty-six miles an hour. Compare this with an express on the Lake Shore and Michigan Southern Railway which did the journey between Buffalo and Cleveland, 183 miles, in 187 minutes, exclusive of stops. Allowing for time consumed in slowing down, 172 miles of the distance was run in 161 minutes, averaging 64·26 miles an hour. Short distances were covered at the rate of seventy-five miles an hour.

The Orient Express leaves Paris for Constantinople, and now takes only three days to do the journey. By leaving London at 9 a.m., and travelling by Chalons, one reaches Vienna at 5.50 the following evening, Budapest at 11 p.m., Belgrade at 6 a.m., Sofia at 4 p.m., and the conclusion of the third day finds you at Constantinople.

The Indian mail train chartered by the British Government traverses 1375 miles, and in forty-eight and a quarter hours reaches Brindisi, where the passengers take a steamer for Alexandria, and from there reach Bombay in fourteen days from London.

FIRST ELECTRIC RAILWAY.

The distance between Paris and Marseilles (536 miles) was in 1888 done in fourteen hours nineteen minutes. The speed has since been raised to fifty-seven miles an hour. The fastest train in France is that between Paris and St Quentin (ninety-five miles), doing the journey in ninety-five minutes.

Germany and Belgium, while not as bad as some other countries in this respect, such as Italy and Spain, are yet far behind England and America in the matter of rapid railway transit, perhaps owing to the fact of state-owned lines and the consequent lack of competition.

The first attempt to apply electric power for the propulsion of railway locomotives was by R. Davidson on the Edinburgh and Glasgow Railway in 1842; but a speed of only four miles an hour was attained and the project was abandoned. Electricity was employed in 1881 by Messrs Siemens & Halske on an electric railway in Berlin; a line being subsequently built one and a half miles long from Charlottenburg to the Spandauer Bock. They also applied the system to a short railway at Amsterdam and to another in Zankerode in Saxony. Great attention was attracted in that year to an electric line at the International Electrical Exhibition in Paris, worked by Siemens. It carried an average of 13,000 passengers per week, few amongst whom did not perceive the possibilities which electricity offered to the future of rapid transit. Two years later an electric railway, six miles long, was opened

between Portrush and Bushmills in the north of Ireland. The conductor employed was a third rail, electricity being transmitted through this conductor by means of steel brushes to the Siemens motor by which the car was propelled. The dynamo machines were driven by the power of a natural water-fall of twenty-six feet, causing two turbines to revolve at a speed of 225 revolutions per minute, each of which was capable of yielding fifty horse-power. The cars on this road ran at the rate of twelve miles an hour. It was not long after this that a number of electric tramways or railways were constructed in various parts of Europe and North America. The Liverpool over-head railway was opened in 1893.

## CHAPTER V.

WHEN Shakespeare made Robin Goodfellow declare that he would girdle this terrestrial globe in forty minutes, it was considered a ludicrous stretch of the poet's imagination. No one could have dared to suppose that the day would come when such a statement would become a mere truism—indeed, a far too modest statement of a fact which has grown commonplace.

The idea of annihilating time and space in communication by distant signals is sufficiently ancient to have occurred even to the most uncivilised tribes. The North American aborigines were wont to convey intelligence thus from

hill to hill, and the Hottentots communicated with each other by means of hill-top fires.

It is not requisite to mention the various means of conveying information to a distance by means of sound known to our ancestors, but it might be profitable to glance at the origin of Telegraphs, before electricity came to be employed.

The first practical telegraph dates from 1684, and was that of Dr Hooke, the mathematician, an inventor of many ingenious instruments. His method consisted in exposing successively as many different shaped figures or signs as letters are contained in the alphabet. If used in the day-time, they might be squares, circles, triangles, etc., and at night torches or other lights disposed in a certain order. These characters or signs were to be brought forward from behind a screen attached to a moveable rod. Of this "telegraph" the stations were to be at such convenient distances as to enable the signals to be seen with a moderately powerful telescope. It is obvious that such a plan, although clever, was also very complicated, owing to the number of signals. But its inventor was so confident of its practical utility that he declared that "the same character might be seen at Paris within a minute after it had been exposed in London." It is certainly a pity that the system was not tried, at least between London and York or Edinburgh.

More than a century later, when Europe was in the throes of war, many experiments were made with the telegraph, the principal object

being to simplify the mechanism, which in all the earlier forms of telegraphic apparatus was of a decidedly clumsy nature.

The first to render a telegraph available for practical purposes was probably Amontons in 1690. It is related by Fontenelle that he invented "a means to make known all that was wished to a very great distance—for example, from Paris to Rome—in a very short time, three or four hours, and even without the news becoming known in all the intervening space." This proposition, so paradoxical and chimerical in appearance, was executed over a small extent of country. The secret consisted in placing in several consecutive stations persons who, by means of telescopes, having perceived certain signals at the preceding station, transmitted them to the next and so on in succession; and these different signals were so many letters of our alphabet, of which the key was known only at Paris and Rome.

Other attempts were made in the course of the ensuing century to induce the French Government to take up various schemes of telegraphy. At last, when the century was plunged into the horrors of war, one Claude Chappe laid plans before the Legislature in 1792, assuring them that "the speed of the correspondence would be such that the legislative body would be able to send their orders to the frontiers and receive an answer back during the continuance of a sitting."

After much vexatious delay the authorities approved of the scheme, and Chappe with the title of Ingénieur Télégraphe, was directed to construct a telegraph from Paris to Lille. The

line, with its apparatus (a combination of a pole, a beam, moveable arms and ropes), which allowed of the transmission of 192 different signals, was completed in two years. The first message sent announced a victory. On the last day of November 1794, Carnot entered the Assembly with the news, "Condé is given up to the Republic! The surrender took place this morning at six." The Chamber voted that "the army of the North had deserved well of the country"; this message was sent instantly to headquarters, and before the day's session broke up, the members were informed that their orders had been transmitted 150 miles to Lille and acknowledged by the commander there.

Such a successful result of course led to the immediate formation of other lines which radiated from the French capital to all parts of the kingdom. The signals (depending on varying positions of the beam and arms) were conveyed with great rapidity; and to avoid confusion, the moveable arms on the right of the central post were reserved exclusively for Government messages, those on the left being employed in the service of the line. By this means, accidents or delays could be reported without detriment to the official despatch; and the Government was enabled to employ a cipher code of its own.

From Paris to Calais, a distance of 152 miles, there were thirty-three stations, and a message could be sent from one extremity to the other in three minutes; to Strasburg, 255 miles and forty-four stations, in six and a half minutes; to Toulon, 317 miles and 100 stations, in twenty minutes. The longest lines were to Brest and

Bayonne, the former 325 miles, the latter 425; and altogether there were 519 stations, the annual cost of the service amounting to £40,000. The brothers of the inventor Chappe succeeded him in turn, the last being in office until 1830, when the Revolution of that year deprived him of his post.

A system of such value could not but be instantly appreciated by neighbouring countries, whose enterprising inventors proposed to each Government various forms of apparatus. Among those who submitted their plans was the father of the celebrated Maria Edgeworth, who contrived a telegraph of four wedge-shaped boards, mounted on the tops of poles and so pivoted as to assume various positions. Edgeworth believed his system was easily capable of serving for the transmission of messages all the way between England and India.

Another inventor, named Gamble, devised an apparatus of shutters to fill the openings in a window frame, different signals being conveyed by the alternate opening and shutting of the spaces. Lord George Murray in 1795 substituted a different arrangement of shutters; they being six in number, painted black, the different letters and figures being indicated by the situation of the open shutter. The Admiralty adopted this plan for a telegraph between London and Dover. In 1806, Davis's sliding shutter increased the value and celerity of Murray's arrangement, but ten years later the whole principle of shutters was abandoned by the authorities for a modification of the older moveable arm system. In 1816 the telegraph or semaphore, long familiar

to the public, on the roof of the Admiralty, was erected. It was invented by Sir Home Popham and consisted simply of an upright pole with two moveable arms. It was not capable of a large number of signals; but it proved simple and effective and the angular position was easily seen at a distance. The time between London and Dover was reduced for long messages, and Popham's telegraph continued in use until it, and all its kind, was superseded by the wonder-working magnetic flash. It was, of course, quite useless at night, or in fogs and dull weather; and for three quarters of the year the telegraph from the capital to Portsmouth stood idle. As an illustration of one of its drawbacks, on one occasion, when tidings of moment were expected from Spain, the Admiralty officials received a message —"Wellington defeated." The utmost disappointment and depression prevailed, until the arrival of the royal messenger with the despatches, when it was found that the fog had delayed the rest of the message, which should have been "Wellington defeated the French at Salamanca."

But the era of electro-telegraphy was now at hand, and a means was about to be adopted which placed all the laws of time and distance at defiance. As far back as 1736 Stephen Gray had found that by means of pack threads, more than 100 ft. in length, the electric current could be transmitted to a considerable distance.

In France, two other experimenters, Dufay and Nollet, sent a current along a wet cord 1300 feet. Dr Watson carried a wire across the

Thames at Westminster Bridge, one end being in contact with a charged Leyden jar, the other held by a person on the opposite shore. Another individual was placed in communication with the jar, and on a given signal both dipped an iron rod into the river, whereupon the shock travelled from one bank to the other by means of the wire, and completed the circuit by returning through the water. That this discovery was of a most important character it is not necessary to emphasise, seeing that it involved the principle governing all subsequent experiments in electrical transmission of this kind.

Hardly had the nature of this new and most astounding agency become known than it was followed in various quarters by proposals to employ it in the conveyance of signals. It is related that as early as 1773 Odier wrote to a lady of his acquaintance: "I shall amuse you, perhaps, in telling you that I have in my head certain experiments by which to enter into conversation with the Emperor of Mogul or of China, the English, the French, or any other people of Europe, in a way that, without inconveniencing yourself, you may intercommunicate all that you wish at a distance of four or five thousand leagues in less than half an hour! Will that suffice you for glory?"

This vivacious spirit was not alone. In 1774, Lesage, a Frenchman at Geneva, published a plan for an electric telegraph. He proposed to arrange twenty-four metal wires in some insulating substance, each connected with an electrometer, from which a pith ball was suspended. On

exciting the wires by means of an electrifying machine, the movements of the twenty-four balls represented the letters of the alphabet.

Under date of September 16, 1787, Arthur Young, in his "Travels in France," remarks: "In the evening to Monsieur Lamond, a very ingenious and inventive mechanic. In electricity he has made a remarkable discovery. You write two or three words on paper; he takes it with him into a room and turns a machine enclosed in a cylindrical case, at the top of which is an electrometer, a small, fine pith ball; a wire connects with a similar cylinder and electrometer in a distant apartment; and his wife, by remarking the corresponding motions of the ball writes down the words they indicate. . . . As the length of the wire makes no difference in the effect, a correspondence might be carried on at any distance; within or without a besieged town, for instance; or for a purpose much more worthy, and a thousand times more harmless—between two lovers prohibited or prevented from any better connections." Here, then, was a complete electric telegraph on a limited scale, and yet years were to elapse before it was put publicly into practical effect.

We have seen that Chappe's invention of signals was adopted instead, and probably delayed the discovery or employment of voltaic electricity. In 1796, Salva, a Spanish physician, constructed an electric telegraph, which was made useful; and soon afterwards a more extensive attempt was made by Betancourt, who stretched wires from Aranjuez to Madrid, forty-five miles

distant, conveying signals by the discharge of Leyden jars. But nothing really came of these attempts, for although the transmission of signals over a considerable distance by electro-static methods such as these may be theoretically possible, it cannot be carried out in practice. To mention only one difficulty, whatever precautions might be taken, leakage would be so enormous as to render an actual installation of more than a few yards unworkable. It was not until the invention of the electric battery, and the discovery of the properties of electric currents and electro-magnets, that an electric telegraph became a possibility.

In 1816 Ronalds sent signals by frictional electricity through eight miles of wire at Hammersmith. This same inventor proposed the adoption of an electric telegraph to the Admiralty, and in a volume published on the subject in 1823, remarked that if he "should be proved competent, why should not our kings hold councils at Brighton with their Ministers in London? Why should not our Government govern at Portsmouth almost as promptly as at Downing Street? . . . Let there be electric-conversation offices, communicating with each other all over the kingdom."

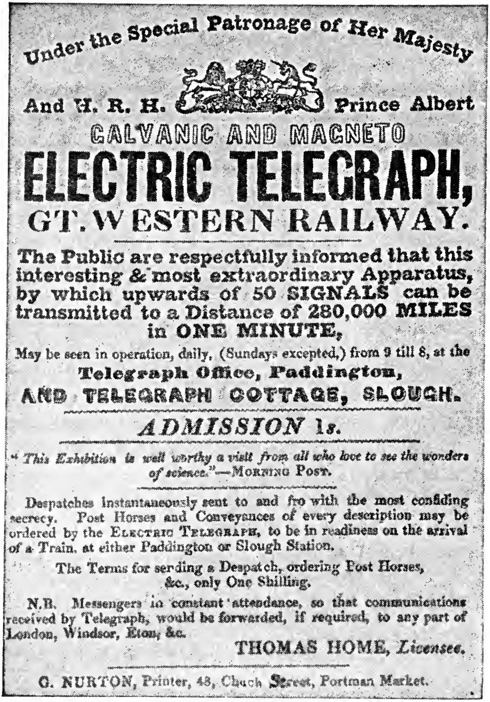
During the next fifteen years many experimenters were at work on the problem of the electric telegraph.

It is claimed for Professor Morse, an American, that he invented the first electro-magnetic telegraph while on a passage from Havre to New York in 1832. But no account of this performance was published until 1837, when Schilling, Gauss and Weber, Steinheil and Wheatstone

had achieved considerable success in the construction of electric telegraphs. The first message by the Wheatstone-Cooke system was sent between the Euston and Camden Town stations of the London and North-Western Railway on the evening of July 25th, 1837.

Morse's contrivance included a marker at one end of a wire, which, as contact was made or broken, conveyed an arbitrary alphabet of dots and strokes, representing definite characters. Wheatstone (whose first patent was taken out in 1837) soon made improvements which greatly simplified his first methods; the number of wires was reduced to two, and thirty letters could be indicated in a minute. A new field for observation was opened up for the world by Wheatstone. He showed that inasmuch as electricity travelled at a speed which would girdle the globe seven or eight times in a second, it could be employed in measuring the rate of motion of projectiles, or regulate the movement of all the clocks in the country. With the proper mechanical accessories a "lady seated in her drawing-room in London might play Beethoven's sonatas on the piano of her friend at Edinburgh; or a ringer in St Paul's belfry might entertain the frequenters of the Parliament Square with a lively carillon from the Tower of old St Giles's."

The first example of the electric telegraph for commercial purposes was in connection with the Blackwall Railway, opened in 1840. The announcements of departures, of stoppages, of the number of carriages attached, of accidents or causes of delay were regularly transmitted by




EARLIEST ADVERTISEMENT OF THE ELECTRIC TELEGRAPH.

Queen Victoria made use of the wires mentioned in these handbills for her first telegraphic communication with her Ministers in London.

electro-magnetic apparatus, placed at each of the five intermediate stations.

Two years later, the system had been adopted on the London and North-Western, South-Western and other lines. It had not been long completed on the Great Western when a striking instance occurred of the service which the new invention was to render to society. A man of respectable exterior took his seat in a first-class carriage at Slough, eighteen miles from Paddington—he was a murderer fleeing from the yet warm body of his victim. The hurrying engine neared the terminus: the desperate man felt certain of his escape; but he had not reckoned on the speed of the telegraph. An alarm had been given at the scene of his crime; quick as a flash the wires bore it to London, describing the man's flight and personal appearance. In three minutes an answer announced the arrival of the train, the identification of the fugitive, and the certainty of his capture.

This, and other incidents of a similar kind, naturally created a deep impression on the public mind. On the birth of the new year (1845) a telegram transmitted from Paddington was received at Slough before the old year had expired, there being a sufficient difference of longitude to be marked by the velocity of the mysterious new agent.

We are now so accustomed to the rapid public record of passing events by the newspapers as hardly to understand the patience of the reading world prior to the era of the telegraph.

The first newspaper report received by wire

appears to have been of a public meeting at Portsmouth, during the railway mania of 1845, which created such interest in London that the *Morning Chronicle* printed it an hour or so after the meeting broke up. The other newspapers, receiving their reports by train, which took three hours, followed the example the next day. After this, the proprietors of a Southampton journal resolved to print the Queen's Speech without waiting for the railway. The report was transmitted, letter by letter, and the 3600 letters were set up in type in Southampton two hours after delivery in Parliament. The only limit now was the expense: and news telegrams accordingly began to appear regularly in the press.

The old signalling system or semaphore still lingered on at the Admiralty until 1848, in which year the new electric telegraph was substituted.

Two years before the Electric Telegraph Company had been incorporated, with a central establishment in Lothbury. The premises were amply equipped with all the necessaries of telegraph service; and by means of wires, laid in tubes underground, was connected with all metropolitan railway stations, the Post Office, the head police station in Scotland Yard, the Admiralty, the New Houses of Parliament, Buckingham Palace, and many other public buildings. In addition, communication was made with various places in the Provinces including the chief towns and seaports. "Electric telegraphs," declared the Parliamentary

statute, "shall be open for the sending and receiving of messages by all persons alike, without favour or preference, subject to a prior right of use thereof for the service of Her Majesty and for the purposes of the Company." A proviso is also made in favour of the Home Secretary of State, who may, on extraordinary occasions, take possession of all the telegraph stations and hold them for a week, with power to continue the occupation, should the commonweal demand it. There were established in Edinburgh, Manchester, Liverpool, Glasgow, Hull, Newcastle and other towns, subscription news rooms, for the accommodation of the mercantile and professional interests, to which was transmitted by electric telegraph the latest intelligence, including domestic and foreign news; shipping news; the stock, share, corn and other markets; parliamentary intelligence; *London Gazette*; state of the wind and weather from numerous places in England; and the earliest possible news of all important occurrences. Other companies soon followed, to the number of seven or eight; a period of competition set in, and in 1861 the United Kingdom Company established shilling telegrams, without reference to distance. For some years this charge—double what it is at present—was found unremunerative, and at length an agitation sprang up for the acquisition of the whole telegraph system by Government.

The rise of electric telegraphs in France was at first remarkably sluggish. The reason for this was that the Government had spent a great deal

of time and money in developing their system of semaphore telegraphs; and even when they were induced to avail themselves of electricity, it was stipulated that the signals should still be produced by small instruments, similar in principle and construction to Chappe's apparatus. At length, however, this absurd stipulation was withdrawn, instruments and equipments similar to those in use in England were acquired by the French Government, and by 1847 telegraphs from Paris to Orleans, to Rouen, Lille and Calais were brought into operation.

A curious economical advantage resulting from the new system in France was the saving of locomotive power on the railways; for in accordance with the practice on the French lines, whenever a train was twenty minutes late, an auxiliary engine was despatched to its relief from one station after another along the route. By 1850, 1500 miles of telegraphs were complete and in progress in France.

It was not long before every country in Europe began gradually to feel the benefit of this wonderful medium of communication. Already in 1850, the ramifications of telegraphs extended from Calais to Moscow, from the Baltic to the Mediterranean. "Already," said one writer, "there is talk of introducing the thought-flasher into that land of wonders—Egypt; to stretch a wire from Cairo to Suez for the service of the over-land mail. Who shall say that before the present generation passes away, Downing Street may not be placed in telegraphic *rapport* with Calcutta?"

After this suggestion appeared, progress was so rapid that in 1861 Europe boasted 100,000 miles of telegraphic wire; and in 1865, Downing Street actually was "placed in telegraphic *rapport* with Calcutta."

In America, it need hardly be said, the telegraph was from the first most extensively developed and applied. The lines were in many cases carried across country, regardless of travelled highways, over tracts of sand and swamp, and through the wild primeval wilderness. "Away it stretches—the metallic indicator of intellectual supremacy, traversing regions haunted by the rattlesnake and the alligator—solitudes that re-echo with nocturnal howlings of the wolf and bear." Rapid communication was thus made possible from North to South, East and West, through all the length and breadth of the Republic with a frequency and cheapness long exceeding any other nation. This superiority has, since the establishment of sixpenny telegrams, been transferred to the United Kingdom.

And now we come to telegraphing without wires. It was conjectured by Faraday, Helmholtz and others that light from the sun and electricity were of the same order, only differing in degree, *i.e.* in the lengths of their respective waves. Their velocity through space was the same, namely 186,400 miles a second. Light waves, heat waves and electric waves in travelling from the sun to the earth—a distance so great that an express train travelling sixty miles an hour would take 175 years to accomplish it—reach our earth in eight minutes. These waves

cannot travel along nothing: they must have an elastic medium which will transmit them. If the ether be capable of conveying electrical energy from the sun without loss and without intervening wires, it was reasonable to ask: Why cannot some form of instrument be devised which will also send out along the terrestrial ether electrical currents, even in a small way? Air must not be confounded with ether. One set of vibrations may concern, perhaps, thousands of waves per second, but those in the ether are reckoned by hundreds of millions, hundreds and even thousands of billions per second. For example, if in a thunderstorm, three miles distant, we see a flash of lightning, the light waves in the ether reach the eye at practically the same instant the flash occurred; but the noise of the electrical discharge travelling through air travels only 1150 feet a second, and so would not reach us for fourteen seconds. In this time the electrical current would have circumvolated the earth at least 100 times. Yet although there is such a wide difference in rapidity between the air and ether waves, yet they bear much resemblance to each other, as is seen in practical experiments in syntony. Every musician knows that if a violin and a piano be in the same room and are tuned to each other, a note sounded on the violin will find a response in the piano, if the dampers be raised from the strings, by actuating the pedal. In the same manner, in all recent experiments with the Hertzian waves, a system of "tuning" is resorted to, in order to establish perfect unison between the receiving apparatus and the trans-

mitter. So important is this tuning or syntony between waves that the privacy of messages sent and received by wireless telegraphy may be secured by it.

The first to suggest a method of signalling across space without intervening wires was J. B. Lindsay of Dundee about 1853. In the following year he patented his invention and conducted experiments in London and Portsmouth, where he successfully telegraphed without wires across 500 yards of water. After a lapse of thirty-four years, in 1887-88, other experiments were made through the air by direction of Sir W. Preece, who some years later successfully sent messages across a distance of four and a half miles by the use of dynamic electricity. Static electricity was first used by Hertz, when it was found that waves or vibrations passing through a wire set up similar vibrations in the other. These waves vibrate in all directions, and by very delicate receiving instruments it was found possible to gather them up in sufficient strength to repeat their pulsations and record their messages from the transmitter.

The next important step was the invention, by Edward Branly of Paris, of a sensitive detector which was improved by Sir Oliver Lodge, who called it a coherer, and afterwards adopted in the Marconi system. Mr Marconi in 1896 took out his first patent, producing the first transmitter capable of sending messages over long distances. From that time onwards he has continued, by many improvements, to build up the wonderful system that bears his name, and which is now in constant use all over the world.

Following closely on the success of wireless telegraphy is that still more wonderful science of wireless telephony, the possibility of which was first demonstrated in 1906. The earliest systems, which were patented in America as far back as 1901 and 1902, were those of De Forest and of Fessenden. Other inventors have also come to the fore, and great progress has been made. One system, invented by Dr Poulsen of Copenhagen, is said to have achieved a range of 175 miles over land and 250 over water. Wireless telephony has one great advantage over wireless telegraphy, and that is, that when the system is disturbed and signals are faint and confused, a voice is much more easily detected than the click of a telegraphic signal.

The reality of the new science may thus be illustrated: The S.S. *Umbria*, like all the boats of the Cunard Line, is fitted with the Marconi system of wireless telegraphy. She set out from New York, May 31st, 1902, and was soon in mid-ocean. The American ambassador, speaking at a concert on board, could only express a hope that on landing the news of the conclusion of war in South Africa might be imparted. He reckoned without science. Late on that night a Marconi message was received giving the news of peace and—the winner of the Derby! It has become a regular experience on the Atlantic boats, at whatever distance from land, to see, as in a London club, the servants carrying round telegrams, and calling the name of the recipients. The lonely sea has thus lost another of its terrors.

Another striking example of the value of wireless telegraphy was provided by the terrible *Titanic* disaster of 1912. Had it not been for the wireless appeal for help received by the *Carpathia*, there is little doubt but that the loss of 1490 lives would have been greater by many hundreds.

## CHAPTER VI.

"THE restless spirit of modern invention, not content with guiding the mysterious power of electricity, both above and beneath the surface of the earth, proposes next to join the shores of England and France by means of a submarine telegraph. That such an undertaking is possible there is but little doubt; but the question is, would it be worth while to attempt to carry it out?" The author of the foregoing in a work on Telegraphs, published in 1848, decides in the negative, for, says he, "the injuries to which the wires would be subject, appear to create almost an insuperable objection to this plan being carried out on a large scale."

As yet we have seen that the speediest communication between any points separated by the sea was by means of the fast steamers, which had now replaced the fast sailing ships of the beginning of the century. Dover and Calais, as well as London and New York, were solely dependent on steam to convey at the most rapid rate tidings upon which the fate of nations might hang.

In 1845 an American newspaper boldly pre-

dicted that the Atlantic would one day be spanned by an electric wire, to interchange thought between the two great English-speaking nations. The idea was derided as extravagant, but many inventors had been experimenting in submarine telegraphy, and in 1847 there came the actual submarine line in Portsmouth Harbour. The success of this led to projects for similar wires or cables, and three years later, on the 28th August, after certain preliminaries, the *Goliah* steamer started from Dover with a huge reel on her deck, containing twenty-five miles of wire, coated with gutta percha, which was slowly and gradually unwound and submerged in the water of the Channel. That same evening a message flashed from under the sea to the horse-box which served as a temporary office on the English coast: "We are all safe at Cape Grisnez: how are you?" Thus international communication by electricity was achieved; and although it was soon interrupted by the frailty of the cable, which broke against the rocks, yet another year saw it partake of a solid and permanent character. At the outset the new method of communication was only used for the transmission of Stock Exchange intelligence; but on the 21st November 1851, the political news from Paris published by the *Times* demonstrated in striking fashion what a singular power had now been developed.

Private messages (at a fixed rate of charge) began to be sent, and early in 1852 London was placed in direct telegraphic communication with nearly all the chief cities of the Continent, *via*

this single cable. Prior to this year the announcement of the death of a monarch or prime minister, the overthrow of a State or army, might have been transmitted under exceptionally favourable circumstances from the English to the French capital by means of the signalling telegraph in a comparatively short space of time—say, in a few hours. But to the public generally, and for the despatch of messages of merely private moment, the only agent was steam and the post, and this agent required in 1850, 21 hours to travel between London and Paris, 52 hours between London and Berlin, and six days between London and St Petersburg. In 1853 a private message from Windsor was delivered in Paris in two and a half minutes.

In the previous year Ireland had been linked to England by a marine cable between Holyhead and Howth; submarine cable companies began to spring up in all directions in that year, and lines were soon laid in great number all over Europe, even as far as the Black Sea and the Red Sea. Many of these were at work when the magnificent idea presented itself of a cable across the vast stretch of the Atlantic Ocean. Already, in 1851, a plan was formed for connecting Newfoundland and the Canadian Maritime Provinces with America, and two years later the work was begun. Financial difficulties, however, overtook the project, and it was not until Mr Cyrus Field lent his energy his counsels and his wealth to the major task of spanning the ocean that this part of the work was completed.

On the 7th August 1857, the two ships carry-

ing the great Atlantic cable left the harbour of Valentia, Ireland. There was no ship in the world at that time (for the *Great Eastern* was unfinished) capable of carrying the whole 2500 miles of cable, which was to stretch to Trinity Bay, Newfoundland. The British Government, therefore, lent the *Agamemnon*, and the American Government the *Niagara*, to divide the work. The shore-end was landed and received with ceremony by the Lord-Lieutenant of Ireland on the Valentia beach, he expatiating on the fervent hope of establishing "a new material link between the Old World and the New." But the enterprise was destined to temporary failure: the cable broke and the ships returned. After a disheartening delay, a new plan was decided upon. The two ships steamed out together into mid-ocean, where the two cables were spliced and submerged, and then each ship began steaming, one east and the other west. But they had not proceeded far when the cable snapped again; again it was spliced, and once more was it broken, this time in two places. Thus there lay at the bottom of the ocean 144 miles of cable and the whole rendered worse than useless. Nevertheless, the projectors were plucky men; they resolved to try again, and the third Atlantic cable-laying expedition met with success—a temporary success, it is true—and the first lightning message sped across the Atlantic on 6th August 1858. Ten days later Queen Victoria cabled the following message, which took but sixty-seven minutes in transmission over 4000 miles from London to Washington:—

"To the President of the United States. The Queen desires to congratulate the President on the successful completion of this great international work, in which the Queen has taken the deepest interest.

"The Queen is convinced that the President will join with her in fervently hoping that the electric cable which now connects Great Britain with the United States, will prove an additional link between the nations whose friendship is founded upon their common interest and reciprocal esteem.

"The Queen has much pleasure in communicating with the President, and renewing to him her wishes for the prosperity of the United States."

President Buchanan replied in a similar spirit, declaring that the new enterprise was a "triumph more glorious, because far more useful to mankind, than was ever won by conqueror on the field of battle," and trusting that "even in the midst of hostilities, the cable would be regarded as neutral by all nations." The rejoicings over the cable of 1858 were great; but, alas, they were speedily cut short. The electric impulses became weak, and gradually failed after having conveyed a total of 400 messages between the two hemispheres—the last word transmitted being—curious to tell—"Forward."

For five years following, no further capital was forthcoming to make another attempt. But in 1865 a Company was organised; this time the cable made heavier, and the whole length, 2300 miles, was shipped on board a single vessel, the

*Great Eastern.* Still again, when the vessel was 1064 miles from Valentia, the cable broke, owing to an accidental strain, and after a futile attempt to recover it from the bottom of the sea, it was abandoned for the season. In the following year, another line was at last successfully laid by the *Great Eastern*, the former cable recovered, and thus the Old World and the New were permanently joined together in an intellectual bond.

Its success led to other cable systems. In 1869 a French Company laid a line from Brest to St Pierre, an island off Newfoundland; in 1873 a cable was laid from Lisbon to Pernambuco, in South America. Two other Atlantic cables were laid in 1874 and 1875: and several others since. The Pacific Ocean had to wait longer for a cable: but one was finally established to Honolulu, and in 1903 there are two others to bridge the vast expanse between North America and Asia and Australia, thus girdling the earth with wire.

As a means of rapid communication—rivalling even the telegraph—a place must be found in these pages for the telephone, whose introduction into Europe dates only from 1877.

The idea of transmitting sound to a distance may be traced back to remote antiquity; its first practical expression was found in the speaking-tube, and, in more modern times, in the string telephone.

In 1667 Robert Hooke relates how by the aid of a tightly drawn wire, bent in many angles, he conveyed sound to a very considerable distance.

"'Tis not impossible," he writes, "to hear a

whisper at a furlong's distance, it having already been done; and perhaps the nature of the thing would not make it more impossible, that furlong should be ten times multiplied. And though some famous authors have affirmed it impossible to hear through the thinnest plate of Muscovy glass; yet I know a way, by which 'tis easy enough to hear one speak through a wall a yard thick. It has not yet been thoroughly examined how far Otacousticons may be improved, nor what other ways there may be of quickening our hearing, or conveying sound through other bodies than the air." He assures the reader that he has "by the help of a distended wire propagated the sound to a very considerable distance in an instant."

Again, in the "Repository of Arts," September 1, 1821, there is a description of an instrument invented by the electrician, Wheatstone, and called a "telephone." "Who knows but by this means the music of an opera performed at the King's Theatre may ere long be simultaneously enjoyed at Hanover Square Rooms, the City of London Tavern, and even at the Horn's Tavern at Kennington, the sounds travelling like gas through snug conductors from the main laboratory of harmony in the Haymarket to distant parts of the metropolis? . . . And if music be capable of being thus conducted, perhaps words of speech may be susceptible of the same means of propagation."

Sixteen years later Page, an American, found that a magnetic bar could emit sounds when exposed to rapid alternate magnetizations and

de-magnetizations. By rapidly approaching the poles of a horse-shoe magnet to a flat spiral coil traversed by a current, he obtained a sound termed the "magnetic tick." De la Rive, Gassiot, and Marrian remarked the same phenomenon in a soft iron bar surrounded by a helix, at the moment that this helix was traversed by a current. When these vibrations became frequently interrupted, they gave rise to a distinct sound of considerable intensity, and when the interruptions were sufficiently rhythmic and rapid, a musical note ensued.

Charles Bourseul, a Frenchman who in 1854 published a pamphlet on the electric transmission of speech, foresaw clearly to what all this would lead. "Suppose," he says, "that a man speaks near a moveable disc sufficiently pliable to lose none of the vibrations of the voice, that this disc alternately makes and breaks the currents from a battery, you may have at a distance another disc which will simultaneously execute the same vibrations. . . . It is certain that in the more or less distant future speech will be transmitted by electricity."

A few years afterwards Phillip Reis began his experiments, and in 1868 actually succeeded in constructing a working telephone by means of the galvanic current. It was, however, principally intended to reproduce musical sounds, and although it did convey the human voice, its powers of transmission were of a limited order. Improvements in the musical telephone were made by succeeding inventors; but it was not until 1876 when Alexander Graham Bell and

Elisha Gray, working separately and without collusion, each produced a speaking telephone, that the dream of articulating telephone became realised.

Strange to relate, both inventors applied for patents on the same day, February 14th. The question of priority led to a celebrated lawsuit, and ended in a compromise, one company taking up the patents of both inventors. Bell, however, had made important developments in his instrument, while Gray did but little to improve his invention after applying for a patent. As every one is aware, a telephone consists of a transmitter and a receiver, the former being the instrument into which words are spoken, the latter the instrument which is applied to the ear. The receiver has remained virtually the same as described in Bell's patent, but this is not the case with the transmitter, which is to-day another device altogether. In lieu of the original magnetic telephone, a carbon transmitter, involving the use of a battery, is now universally employed. This invention is due to Edison, who devised it in 1877, soon after the first Bell telephone was made. It was subsequently replaced by the microphone of Hughes.

In the earlier days attempts were made to use iron wires for both telegraph and telephone lines, the cost of iron wire being so much less than the cost of copper. The vast superiority of copper wire to iron for long circuits is shown by the fact that Rysselburg and others have spoken clearly to a distance of over 1000 miles through a copper wire insulated on poles, whereas Preece

could not work a similar line of iron wire between London and Manchester.

Telephones are now in every city in the world, and have in many become a necessity of daily life, on its social as well as on its economic side.

The new Government telephone system was inaugurated in London in 1902.

Another form of rapid despatch controlled by the Post Office, from which great results in the carriage of human freight is still sometimes anticipated, is that of the pneumatic tube. The transport of written messages by the agency of air-pressure was introduced in 1853 by Latimer Clark between the Central and Stock Exchange telegraph stations in London. These stations were connected by a tube $1\frac{1}{2}$ inches in diameter and 220 yards long. Receptacles containing batches of telegrams, getting piston-wise in the tube, were sucked through it by the production of a partial vacuum at one end. In 1858 Varley introduced compressed air to be used in conjunction with the vacuum principle for the purpose of returning messages along the same tube. The system grew in the hands of the Post Office, until there are now in London alone some forty miles of pneumatic tubes. In addition to its use for postal and telegraphic purposes, the pneumatic despatch is considerably employed for internal communication in offices, hotels, etc., and also in shops for the transport of money and bills between the cashier's desk and the counters. As to the time taken in transit, an ordinary "carrier" weighs $2\frac{3}{4}$ ozs. and holds about a dozen despatches. With a pressure of 10 lbs.

per square inch, or a vacuum of 7 lbs., one minute is required for a length of 1000 yards, and $5\frac{1}{2}$ minutes for a length of 3000 yards. In Paris, where the pneumatic system dates from 1866, large areas of the city have been covered by pneumatic circuits made up of iron pipes, round which long trains of "carriers" are despatched at intervals of fifteen minutes. A similar arrangement is also followed in Berlin and Vienna. Notwithstanding all the developments which have taken place, however, in other departments of rapid locomotion, the pneumatic despatch has made comparatively few strides, and the application of its principle on a large scale is a problem for the future.

Before concluding this chapter it may be worth while to glance back at the conditions which formerly obtained at the Post Office.

Under the postal regime of 1820 it took as long a time to convey a letter from Kingsland to Camberwell, a distance of only five miles, as some twenty years later sufficed for its transmission from the Scottish to the English capital.

The mails were first sent by the railway on 11th November 1830; as the railways extended the Post Office authorities lost no time in availing themselves of the means which railways offer for expediting the transmission of letters.

Before the morning mails were established a letter from Brighton for a town in Yorkshire was stopped fourteen hours in London, as it could not have been transmitted until eight o'clock at night; but it now reaches its destina-

tion (200 miles, say, from London) several hours before it would formerly have left the post-office; again, the Liverpool merchant receives his foreign letters on the same day that they reach London, instead of thirty hours afterwards.

The travelling or railway post-office, invented by Earle, has been adopted by all countries in Europe.

As to the special character of the modern postal system with reference to the saving of time, it is now possible to post a letter in a letter-box in all mail trains, to have it sorted in the train and delivered at its respective town while the train is in motion. The postman has merely to re-sort it at its proper street and slip it in the letter-box of its destined recipient.

Railways carrying the mails are obliged to observe the greatest punctuality. Very heavy fines are imposed upon them if they are late; and it is the same with the mail boats. Government stipulates that the duration of the Channel voyage shall not exceed two hours and five minutes between the Admiralty Pier at Dover and the Jetty at Calais. But inasmuch as this journey is frequently done under an hour, it will be seen that considerable margin is allowed for these days of speed.

The postal department of America is responsible for much of the quickening of the railway trains, which during the last ten years or so has become a prominent feature of American railways. The mail contract is given to the railway which undertakes to convey the letters between given points in the quickest time. Such lucra-

tive traffic naturally causes the competing lines to accelerate their service.

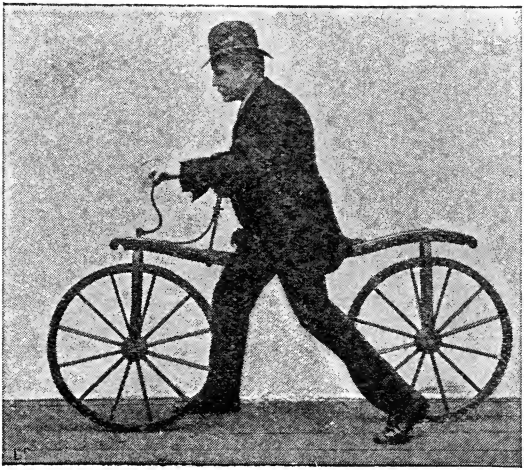
## CHAPTER VII.

WHEN we consider that it is possible for a human animal to propel himself on a pair of wheels without the aid of steam, electricity, or any other agent but his own muscular power, along the earth's surface at the rate of forty-one miles an hour, it is clear that in the bicycle mankind possesses extraordinary means of rapid transit.

Such a means in the eighteenth century and the first thirty years of the nineteenth would of itself have revolutionised the mails and despatch carrying system; but its invention, or rather development, being reserved until the era of railways, of telegraphs, and even of telephones, the economic value of the bicycle has been greatly lessened. Yet it is not a mere instrument of sport and exercise; although even in that character the benefit it confers upon mankind is enormous; it is everywhere, in nearly all civilised countries, an important convenience, offering facilities for transit far superior to the horse, and providing for all classes an always ready, reliable and inexpensive means of rapid locomotion.

The modern cycle is the lineal descendant of the "dandy" or "hobby-horse" of the early years of the nineteenth century, which is to be found caricatured in countless prints of that epoch. It was a bicycle with wheels attached to

a bar of wood rudely shaped like the body of a horse, the rider sitting astride it and propelling it with his feet upon the ground. In 1819 the Baron Drais de Saverbrunn constructed an improved hobby-horse, and this was introduced into England under the name of the "*célérifère.*" It



"THE DANDY-HORSE."

consisted of two stout equal-sized wooden wheels held in iron forks, the rear fork being securely bolted to a bar of wood, the "perch"; the front fork passed through the perch, and was so arranged that it could be turned by a handle, thereby steering the machine after the manner of a modern bicycle. In the middle of the perch

was placed a cushion on which the rider sat; in front of this was another and smaller cushion elevated on a bracket, upon which he leaned his chest. When the rider was seated astride the "*célérifère*" his feet just touched the ground; the machine was propelled by running with long strides, which furnished the momentum during which the rider rested from his efforts. Down hill he could, of course, and did, proceed at a breakneck pace. None of these early "dandy-horses" were fitted with any sort of brake, they were heavily built, and must have rushed down an incline at a startling and dangerous speed. Yet dangerous and ungraceful as the pastime was, it attained great popularity; no young beau's equipment was considered complete without a hobby-horse; and although they were publicly ridiculed, hobby-riding lasted for several memorable seasons until, indeed, several accidents damped general enthusiasm for the sport. One wit described its votaries as gentlemen who rode in their own carriages and walked in the mud at the same time. In one caricature, the blacksmiths of a posting village are seen chasing the hobby-riders, upsetting them and smashing their machines to fragments with hammers, because, forsooth, the hobby-horse, whose use threatened to become general, never required to be shod.

In 1824 there appeared the following advertisement in the *Mechanic's Magazine*:—

"Self-Moving Carriage.

"Mr D. M'Donald, of Sunderland, informs us

that he has invented a self-moving machine for travelling on roads, which has carried seven persons. It is propelled by means of treadles. A man sits behind working the same, and there is a fly-wheel operating upon two cog-wheels which operate on a square axle. You will perhaps think the man behind has hard labour—not so. From the velocity of the fly-wheel, together with the aid of a lever, which is in the hand of a person in front steering, he has not often to put his feet to the treadles. Mr M'Donald intends, when he shall have improved the friction of the body of the carriage, to present the same to the Society of Arts; and as he desires to receive no emolument for the same, he hopes it will come into general use."

In the same year there is recorded another example of these so-called "self-moving carriages" invented by a carpenter of Buckland, and another, a Welshman, describes a lever-action machine, which accommodated three persons, and "went with ease eight miles an hour." All of these self-moving carriages were to be propelled by levers. "Velocipedes," or "carriages to go without horses," "mani-velociters," "bivectors," "trivectors," "accelerators," "allepodes" are amongst the names of machines brought forth in the course of the next forty years.

Yet, although the hobby-horse gradually disappeared from fashionable circles, it had shown that even along an ordinary road it could go faster than a man could run, and for a much longer period. In 1830 we learn that certain

"improved dandy-horses were supplied to the postmen in a rural district, where they were used for many years." But not being replaced when they wore out (except by the railway), the postmen had once again to trudge on foot.

Ten years later, Kirkpatrick M'Millan, a Scotchman, made a wooden bicycle with cranks, side levers, connecting rods and pedals. It was used with considerable success for years, and to its inventor, therefore, would seem to belong the honour of making the first bicycle with cranks. Previously, M'Millan had tried his cranks and side levers on a tricycle in 1835. After him came Gavin Dalzell, a Lanarkshire cooper, with a crank-driven bicycle; and in 1862, Messrs Mayhew, of Chelsea, exhibited a three-wheel velocipede, the front wheel steering as in a modern bicycle or the old hobby-horse, the other two smaller wheels being placed together behind. A pair of cranks was fitted to the front wheel, and on this velocipede it was possible to attain a speed of over ten miles an hour on a smooth track. Four years later, the firm of Michaux, in Paris, sent over to England a perfected bicycle, which, in spite of its weight and clumsiness as compared with the modern machine, seemed then a miracle of grace and lightness. Several of these machines found their way to the London gymnasiums, and became a popular form of sport on a smooth track. One of the earliest long journeys taken in this country was by Mr Mayall, the photographer, who mastered the machine sufficiently to ride from London to Redhill, in an attempt to reach Brighton; "he returned from Redhill by

train, exhausted, and covered with dust and glory." It was only a few months before that Mayall had seen his first bicycle at Spencer's gymnasium. "The gymnasium was cleared," he writes, "Mr Turner took off his coat, grasped the handles of the machine, and with a short run, and to my intense surprise, vaulted on to it, and putting his feet on the treadles, made the circuit of the room. We were some half-dozen spectators, and I shall never forget our astonishment at the sight of Mr Turner whirling himself round the room, sitting on a bar above a pair of wheels in a line that ought, as we innocently supposed, to fall down immediately he jumped off the ground."

It must be remembered that up to that period the possibility of remaining upright on two wheels, arranged bicycle-wise, was not generally admitted.

In a short time, certain English manufacturers began to perceive that this so-called toy had a future: the French machines ceased to be imported, owing to the improvements which were made, and soon the manufacture of bicycles was proceeding on a large scale at Coventry. The changes in structure introduced greater lightness and consequently greater speed: the sport took hold of the public, and bicycles were encountered on every leading road. Those who believed in its ephemeral character, and predicted its early relegation to obscurity, were destined to see the error of their ways. It was found that the new machine could carry a man forty, or fifty, and even sixty miles a day, with less exertion than he

could walk half the distance. In 1869 Mayall started for Brighton at 8 A.M. and arrived at the Old Ship at tea-time. The head-porter, who had never seen a bicycle, was puzzled about the train the new arrival had come by. He was told that no train had brought him.

"Did you drive or ride a horse? Did you walk?" were next asked. "No," was the reply, "I came down on those two wheels yonder in the corner: and if you live long enough you will see thousands of others who will carry travellers to Brighton in half the time it took me to come."

In 1894 Mr Wridgway travelled to Brighton from London and back again in just over five and a half hours.

In June 1873 it was decided to test the new machine by a ride from London to John o' Groats, the most northerly point of the kingdom. Four tourists, Messrs Spencer, Hunt, Leaver and Wood, took part in this long distance ride, on machines which, although of the most improved type in 1873, have little resemblance to the Coventry productions of to-day. The four were escorted for a few miles of their way by friends, but soon distanced their escorts, and that evening the message came to London that they had reached Buckden, sixty-five miles away. On the second day they reached Newark, thus achieving forty-three miles. On the ninth day they gained Edinburgh, and on the fifteenth day saw the party safely landed at John o' Groat's, 861 miles. This was the first long distance ride on record, and attracted a great deal of attention: for it brought home forcibly that a new factor of

speed had been introduced, which, although inferior to the railway, yet was inferior to it alone. How amazed even the riders would have been to know that twenty-one years later the distance between London and Edinburgh would have been covered on a bicycle in twenty-eight hours.

Yet it was not long after their exploit that H. S. Tharp rode from London to York in twenty-two and a half hours. In 1876 Smythe and Caston rode 205 miles in twenty-two hours, the actual time in the saddle being seventeen hours seventeen minutes. *Apropos* of Tharp's performance we may compare it with the advertised journey of the regular stage-coach two centuries ago. "York Four Days Coach Begins The 18th April, 1703. All that are desirous to pass from London to York, or from York to London, or any other place on that road, let them repair to the Black Swan in Holbourne, in London, and to the Black Swan in Coney Street, York, at each of which places they may be received in a stage-coach every Monday, Wednesday, and Friday, which performs the whole journey in four days, if God permit." A copy of the foregoing is still preserved at the "Black Swan," York.

But the innovation was not to come into general use, for the purpose of rapid transit, without opposition. The medical faculty decried it as injurious to the health, and the coachmen and hackney cabmen followed the example of the blacksmiths of 1819 towards the hobby-horse. In August 1876, for instance, the driver of the St Albans coach lashed with his whip a bicyclist who was passing, while the guard, who

had provided himself beforehand with an iron ball on the end of a rope, threw it between the spokes of the machine and dragged it and the rider to the ground. For this assault, the driver was fined £2, the guard £5, and a further penalty imposed of £10 for the damage of the machine.

But cycling was not to be damned by the prejudice of ill-natured or ignorant persons; contests in speed became the order of the day. In 1876, John Keen, who announced himself as the professional bicycle champion, rode fifty miles in three hours six minutes forty-five seconds, and in the following year W. Tomes, of Portsmouth, succeeded in travelling a mile in three minutes ten seconds.

As an illustration of the fact that the future of cycling was not to be limited to sport alone, the Bishop of Manchester publicly stated that a brother bishop had suggested the use of the bicycle in his diocese. So slow was the Conference (and, indeed, the public generally) to appreciate the value of the cycle, that this statement was received with roars of laughter. The Bishop of Carlisle facetiously regretted the hilliness of his diocese, remarking that "if there was one thing a bicycle objected to, it was going up hill." The practical use which would be made by the cycle by hundreds, even thousands, of the clergy throughout the length and breadth of the land, they could not yet foresee. Yet, in this year (1878), the *Times* had this to say on the new vehicle:—

"The bicycle has come to the front and is fighting for existence. Dimly prefigured in the

mythical centaur, and then in the hobby-horse of mediæval games, and attempted in the velocipede, now half a century old; long prejudiced by the evident superiority of wings to wheels, the bicycle has now surmounted the difficulties of construction, and adapted itself to human capabilities—it augments at least threefold the locomotive powers of an ordinary man. A bicyclist can perform a journey of a hundred miles in one day with less fatigue than he could walk thirty; fifty miles—that is, from London to Brighton—as easily as he could walk ten; and a daily journey to and fro between London and the distant suburbs with just the usual results of moderate exercise."

In August 1879, H. Blackwell, jun., travelled on the "steel steed" from London to John o' Groat's in eleven days four hours, while at Stamford Bridge, on a prepared track, a mile was run by Keen in two minutes fifty-two and one-fifth seconds.

When, in 1880, it was decided by the municipal authorities of Coventry to mount its police officers upon the new machine, the circumstance created widespread interest. One commentator, however, suggested that a defaulting debtor pursued by a constable mounted on a tricycle and armed with a summons, sounds more like a horrible dream than a probable reality, and quoted Tennyson's

> "New men, who in the flying of a wheel
> Cry down the past,"

as suitable to the innovation. It may be mentioned that the tricycle dated from 1878, and was the invention of James Starley of Coventry.

It was soon found possible to make great speed on the tricycle, and five years after its introduction C. H. R. Gosset covered over 200 miles in the course of twenty-four hours on the road. At this time, of course, it must be borne in mind that the ordinary bicycle consisted of one great wheel five feet in height, and a smaller one behind only eighteen inches in diameter. The "safety" bicycle, as it was called, did not become general until 1890, and the "ordinary" held its own, until the advent of the inflated tyre made the new machine superior both from the point of view of speed and comfort.

What was regarded as an astonishing feat occurred in 1886, when G. P. Mills travelled on a bicycle from Land's End to John o' Groat's, a distance of 861 miles, in five days one hour forty-five minutes. Some weeks later the same cyclist rode a tricycle over the same course in five days ten hours, or thirty hours faster than it had ever been done before.

As time went on great and still greater speed came to be attained on the cycle—speed which would have caused the early champions of the "silent steed" to gasp in astonishment. In 1890, in a race viewed by the Prince of Wales, F. J. Osmond accomplished a mile in one minute fifty-five seconds on an old-fashioned high bicycle. But the limit of speed on this form of machine had now been reached: the "safety" and the inflated tyre rendered new records possible, and the "ordinary" was soon afterwards completely superseded.

Although the cyclists had already surpassed

the speed attained by the fast coaches in the halcyon days of coaching, yet the coaching revival was to witness several new records, the most celebrated being the performance of July 1888 between London and Brighton. In that month, James Selby drove the Brighton coach from the "White Horse Cellars," Piccadilly, *via* Croydon, Merstham, Red Hill, Horley, Crawley, Hand Cross, Cuckfield, and Clayton to Brighton and back, a distance of 108 miles in seven hours fifty minutes. This remarkable feat was done with sixteen changes of horses.

It was taken as a challenge by the cyclists, who at once attempted to beat it. At first they met with ill success, but at last the journey was done in eight hours thirty-six minutes nineteen and two-fifth seconds, by four riders using the same machine and dividing the journey into four stages. This, however, was not considered satisfactory. P. C. Wilson and M. A. Holbein made an attempt, single handed, but failed, and it was not until 1890 on an inflated-tyre "safety" cycle, that F. Shorland effected the journey in seven hours nineteen minutes. This achievement created great enthusiasm, and was commonly regarded as an unbreakable record. Yet it was not long before S. F. Edge, not only for the first time beat the coach time for the outward journey (three hours eighteen minutes twenty-five seconds), but did the whole in seven hours two minutes fifty seconds.

This was the fastest time ever achieved on a public turnpike by any vehicle whatsoever in Great Britain, and therefore probably in the

world. Yet fast as it was, it was to be beaten again and again, before the advent of the motor car was to demolish all road records; and in 1894, C. J. Wridgway accomplished the excursion in five hours thirty-five minutes thirty-two seconds; even a tricycle, ridden by W. R. Toft, achieving it in six hours twenty-one minutes thirty seconds.

As to other examples of the velocity which can be, and has been attained on the road by means of the cycle, we might mention that the journey from London to York, 197 miles, has been done in eleven hours fifty-one minutes; and London to Edinburgh, 400 miles, in twenty-eight hours twenty-seven minutes; and London to Liverpool in thirteen hours four minutes. One hundred miles have been covered in four hours thirty-nine minutes twenty-eight seconds, and half that distance in two hours seven minutes and fifteen seconds. Great as these instances are, they are surpassed by the speed of the cycle on a prepared track, where 100 miles have been done in two hours, thirty-three minutes, forty seconds; and fifty miles in one hour fourteen minutes, fifty-five seconds.

The cycle, as a useful means of transit, is in universal employment by all classes. In the country it is a favourite method of progression. The tradesmen's emissary adopts it in lieu of the horse and cart for the delivery of parcels, and it is in common use by rural postmen. On the whole, the cycle as a means of rapid transit deserves a prominent place in contemporary economy, quite apart from the facilities it offers for exercise and sport.

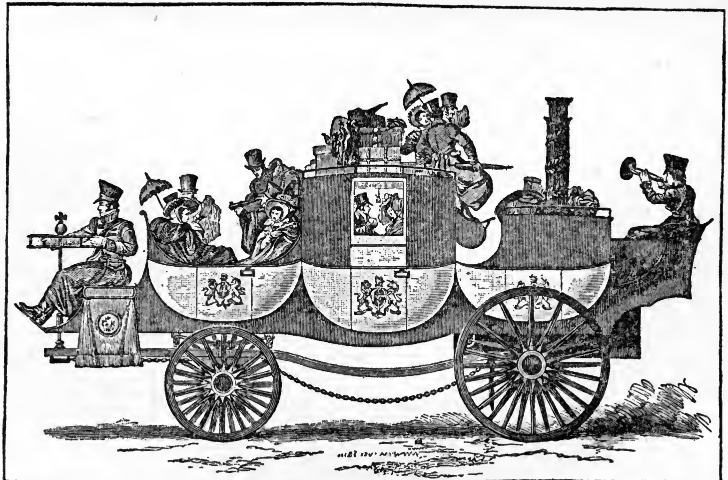
## CHAPTER VIII.

We have already said in an earlier chapter how the necessity for the speedy conveyance of passengers and merchandise came to be widely felt in England early in the last century. If railways had not appeared upon the scene—the development of a new agent of speed would have been inevitable, and that agent would have been the motor car. Railway travelling for the past seventy years has been at best a compromise. The ideal is, of course, a conveyance capable of travelling easily and swiftly to any destination, and not restricted to lengths of rail fixed along a certain route. Railways promptly checked the development of the steam locomotive for the common roads. It was found unnecessary to strive towards the production of a light, speedy vehicle, when a heavy one on an iron track would do as well. Thus, all the early locomotives were what we now designate as motor cars, and are by no means of recent introduction.

Du Halde relates that about the year 1700 the Jesuit missionaries in China invented certain mechanical curiosities for the entertainment of the Emperor Kang-hi. They caused a waggon to be made of light wood, about two feet long, in the middle whereof they placed a brazen vessel full of live coals, and upon them an eolipile, the wind of which issued through a little pipe upon a sort of wheel made like the sail of a wind-mill. The little wheel turned another with an axle tree, and by that means the waggon was set a-running for two hours together. The same

contrivance was likewise applied to a little ship with four wheels; the eolipile was hidden in the middle of the ship, and the wind issuing out of the two small pipes filled the little sails and made them turn round a long time.

It is a matter of conjecture whether this denotes a kind of steam or hot-air engine. It is, however, significant that not many years after Cugnot produced a steam-carriage in Paris, which, after having been proved inefficient, was abandoned, and is still to be seen in the Conservatoire des Arts et Métiers. In 1772, an American, Oliver Evans, commenced experiments with steam with a view to employing it as a substitute for animal power. Evans was sanguine enough to declare that steam would one day be the prime agent of locomotion; and frequently predicted that the time would come when travellers would be conveyed on good turnpike-roads at fifteen miles an hour or 300 miles a day by a device resembling his own. During the next thirty years innumerable were the attempts of English inventors to employ steam-power on common roads. The outlook appeared encouraging; for once they had succeeded with their engine, they need not trouble about railways; excellent highways already existed along which to conduct traffic. In the part of this book relating to railways, mention has already been made of the Cornishman, Trevethick's experiments. Griffiths introduced a steam carriage in 1821; another by Gordon in the following year was contrived to work inside a large iron drum, as a squirrel runs in his revolv-



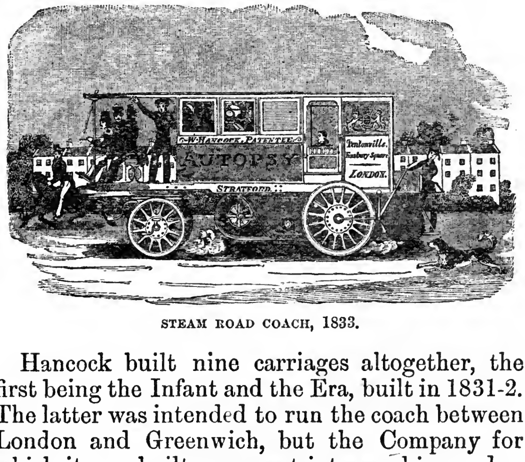
JAMES'S STEAM CARRIAGE.

ing cage, but was quickly abandoned. Gurney next produced his engine, which was marked by clever construction, the objectionable noise being overcome by causing the waste steam to enter a chamber from whence it issued with a steady and noiseless current to the funnel. In 1826 it performed the journey from London to Bath, at which time other competitors were in the field. Dance, Maceroni, Church and Hancock each produced a road locomotive. In 1831, Gurney had three steam carriages running for the conveyance of passengers on the road between Cheltenham and Gloucester, four trips being made daily, at a greater rate of speed than that of the stage-coaches on the same nine miles of road and at half their fares.

This success betokened the permanency of the new enterprise, but prejudice was strong; a formidable opposition was organised, injurious reports were circulated and all travellers cautioned against trusting themselves to the dangers of steam. A more effectual hindrance was offered by the parochial authorities, who covered a portion of the road to a depth of eighteen inches with loose stones. While attempting to surmount this impediment the working axle of the engine was broken and a stop thereby put to steam locomotion in this quarter, for a time. Ere the inventor could renew it local opposition had crushed the whole enterprise.

While this was happening to automobiles at Cheltenham, Hancock started a steam-carriage —the Infant—to run between Stratford and London. It excited much attention owing to

the compactness and efficiency of its arrangements, and led to attempts in other quarters. It was even proposed by the more sanguine projectors to run steam omnibuses in all the great thoroughfares of London—a consummation which has only been brought about after a period of some eighty years—as well as in the suburban districts, and coaches for Birmingham and Bristol.




STEAM ROAD COACH, 1833.

Hancock built nine carriages altogether, the first being the Infant and the Era, built in 1831-2. The latter was intended to run the coach between London and Greenwich, but the Company for which it was built never got into working order. Another, however, the London and Paddington Steam Carriage Company, was started in 1832, and Hancock's next carriage was built to its order. The fourth, he ran daily for twenty-four weeks between Finsbury Square and Pentonville. But although thousands of passengers were carried by these vehicles, yet commercial success

was not very promising for town service at the time, and extended practice and experience were required to make what, even with good roads, would have proved attractive and successful vehicles. Frequent mishaps occurred, and it is to be feared that the comfort of the vehicles was not even up to the standard of the time. The passengers were all in front of the machinery, but with powerful and unbalanced engines, and with the rough chain gear, the vibration was considerable. One, for example, had cylinders no less than nine inches in diameter, and these engines had no fly-wheels. Yet, after all, these things were matters for improvement, which would have naturally followed demand for the coaches, and for improved tools and methods of building.

When Summers and Ogle were examined before the Select Committee of the House of Commons in 1831, they stated that with one of the two steam-carriages of their construction, they had frequently made thirty miles an hour. It was certainly a daring thing these men did in using steam pressures of over 200 lbs. per square inch, in those days of imperfect boilers.

The coaches built by Hills about 1840 would carry nine passengers and a driver, conductor and stoker, at considerable speed, on the precipitous route between London and Hastings. This journey of 128 miles was done in a single day.

But all of these steam coaches and carriages were one after another abandoned, until after the disappearance of Hill's carriage in 1843 not one was left on the road, and none are,

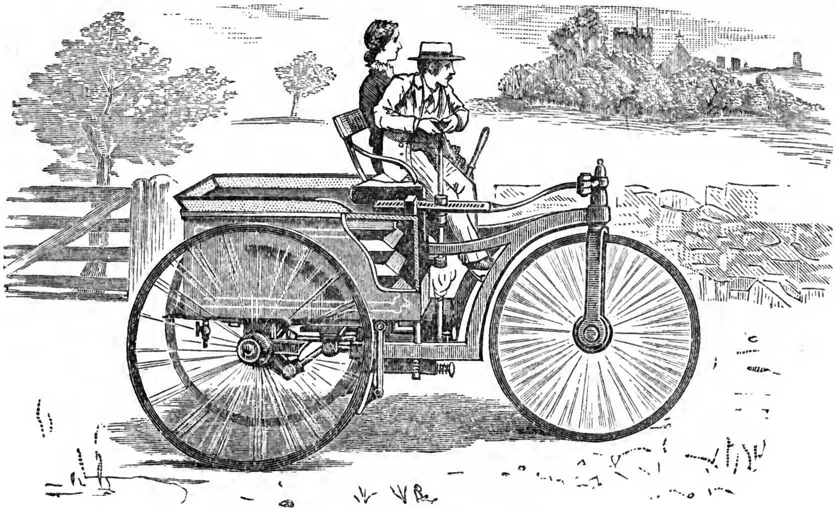

F. HILL'S STEAM CARRIAGE RUNNING BETWEEN LONDON AND BIRMINGHAM, 1839-1843.

so far as is known, preserved. The boorish and unjust treatment meted out to these pioneers effectually put an end to progress in steam road locomotion, so far as this country was concerned, and further harsh and narrow-minded legislation from 1861 to 1878 further prevented England from taking advantage of the progress which had been made on the Continent.

Although Great Britain had for half a century been as near to a practical self-moving carriage as was France when Serpollet, Bollée, Scotte, and De Dion and Bouton began in the early 'nineties, and before the celebrated invention of Gottlieb Daimler enabled Levassor to build his high speed internal combustion motor, and Benz had demonstrated its practicability, this country also possessed the Daimler motor and was aware of Benz's labours, but it would have been futile to attempt to make a motor carriage when Englishmen were without the freedom to use their own roads.

The common roads were consecrated to the uses of horses, latterly of cyclists: to use a mechanically propelled vehicle upon them was considered an outrage. The opponents, therefore, of rapid transit upon the common roads retarded progress and experiment for full sixty years.

Nevertheless, although British inventors were denied facilities for progress in their country, the British public was very quick to reap the benefits slowly derived through foreign genius and industry. France lent free roads to Bollée, Serpollet, Le Blant, and others turned out a succession of ingenious steam vehicles, but it



AN EARLY CARRIAGE DRIVEN BY GAS.

was not until the advent of the Daimler motor and the Benz motor cars, that any real, rapid and continuous progress was made across the Channel.

We have now witnessed the successful employment of steam for traction, and while the world is anxiously waiting for the development of electricity, a new agent appears. Experiments had long been made with gas and hot air as the motive power of engines: science was now ready to experiment with oil and carburetted air. It was known that the lighter oils, such as petroleum spirit (petrol), or gasoline, or benzoline will all evaporate readily in presence of air and especially in air in motion. When the air is saturated with the oil, *i.e.* contains 17·5 per cent., it will burn, giving a fine white light. Such a mixture of oil, vapour, and air will also burn with explosive rapidity under the circumstances of its combustion in a gas or oil cylinder.

Gottlieb Daimler, who had been for some years occupied in gas engine construction, turned his attention to the production of small light petrol motors, made highly powerful by their capability of running continuously at very high speeds of rotation. In 1884 he patented his first high speed gas engine, and in the following year applied his improved invention to a bicycle. This machine was rather clumsy in appearance, but it excited then the deepest interest.

Early in the development of the Daimler motor certain French firms turned their attention to it in very small sizes for propelling tricycles. In 1896 a Dion tricycle ran in the Paris-Marseilles

race, making an average speed over the whole distance of 14·8 miles an hour. In 1899 a motor tricycle accomplished 28·1 miles an hour, being fitted with a $1\frac{3}{4}$ h.-p. motor, or twice the power of the first mentioned. A year or two later these tricycles were fitted with 2·25 h.-p. motors, and some with two-speed gear. They soon became exceedingly popular machines, many persons accomplishing long journeys regularly upon them. In the Paris-Malo race of 1899, 231 miles were covered in seven hours eleven minutes, an average of 32·2 miles per hour.

Carl Benz of Mannheim in 1886 took out a patent for an oil spirit motor tricycle. In this car the piston in the cylinder was connected to a vertical crank-shaft. In the second car made by Benz he ran at about ten miles an hour, while two years later, in 1888, he secured a speed of from twelve to fifteen miles an hour. The inventor seems to have given his cars more liberal size of engine for such small vehicles than many succeeding makers in their first efforts.

It was not until MM. Panhard & Lavassor, of Paris, acquired the Daimler motor rights that the new automobile became popular.

Up to that time, the future of self-propelled carriages seemed to be solely either with steam or electricity. In 1880 the elder Bollée of Mans constructed a steam coach, which went at the rate of ten miles an hour, and numerous automobiles were built during that decade. In 1889 Leon Serpollet invented and made the instantaneous generator or boiler now widely known by his name. As at first constructed, this

generator was composed of a large number of flat tubes, with only a capillary water space. The tubes were surrounded by a coating of cast-iron, which rendered them very heavy, but protected the steel tube from rapid corrosion in the high heat of the furnace in and above which they were placed. It also acted as a heat accumulator during the time when the engines were stopped, and no water was being pumped through for evaporation. The boiler gave very high pressure steam considerably superheated. Various modifications of form subsequently took place, and in 1895 one of Serpollet's carriages was brought to England and tested, the trials exciting considerable scientific interest. But by that time as many as ninety oil or gas driven machines on the Daimler principle had been turned out in Paris, and in order to test the respective merits of the two species of automobile, a race was organised between Paris and Rouen, 79·4 miles. The race was won by a De Dion & Bouton steam tractor, to which was attached an ordinary landau. It made an average speed of twelve miles an hour, and was shown at the first exhibition of motor cars in England, that organised by Sir David Salomons in October 1894.

But the superiority of steam was not to be long maintained. Another race between Paris and Bordeaux, 750 miles, occurred in June 1895, when M. Levassor drove one of his automobiles over the route in forty-eight hours forty-eight minutes at a mean speed of about fifteen miles an hour on the whole run, with a maximum speed of eighteen miles. The carriage weighed

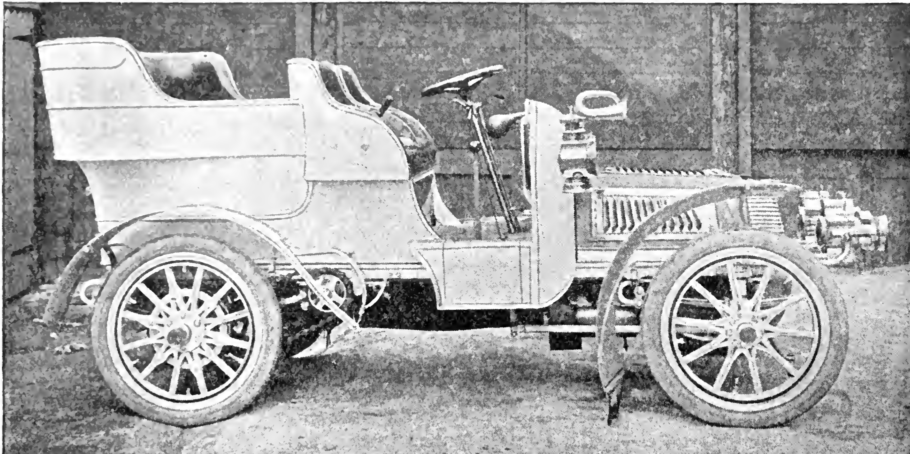
about twelve hundredweight, and won the race, a Peugeot car, also equipped with a petrol motor, coming second.

From that race to the present time, the triumph of the mineral spirit motor has been marked.

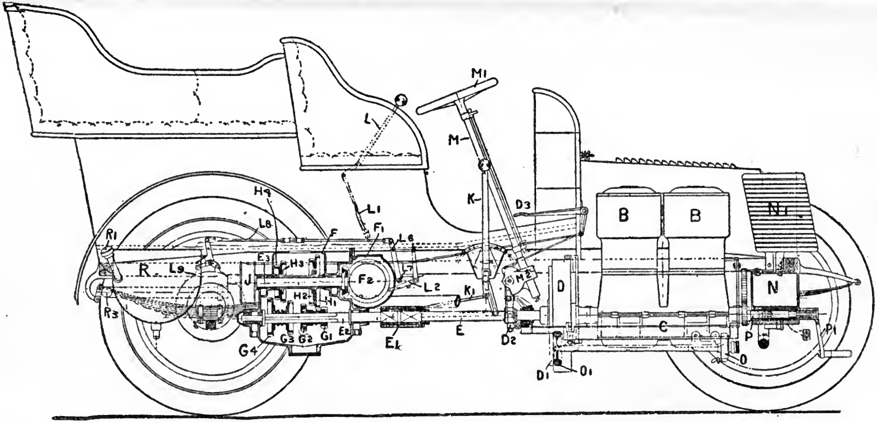
In 1896 in the race from Paris to Marseilles, a distance of 1060 miles, no fewer than thirty-two vehicles started, a Panhard motor covering the distance in sixty-seven hours forty-three minutes, or an average speed of 15·62 miles per hour over the whole of that long run. There were three steam cars among the competitors, but all failed from one cause or another, one, however, only owing to the break-down of its pneumatic tyres, for which it was too heavy.

Nevertheless, a De Dion steam brake run by the Marquis de Chasseloup-Loubat won the Marseilles-Nice race in January 1897, achieving the journey of 144½ miles in seven hours forty-five minutes, or eighteen miles an hour. When fully loaded this brake, with passengers, weighed nearly three tons, but on this run it reached higher speeds than had previously been made, thirty-six miles an hour being attained for short distances.

The records of speed in motor cars quickly began to be lowered. In the Paris-Dieppe race in 1897, a mean speed of twenty-five miles an hour was reached, which placed the automobile on a par with the bicycle in the matter of speed over common roads. The Paris-Amsterdam race in 1898 showed 27·7 miles an hour; in 1899 the Versailles-Bordeaux race, 344 miles without a



DAIMLER MOTOR CAR OF 1903.




MOTOR CAR EXPLAINED.

B1,B, cylinders.
C, crank chamber.
E, shaft.
F, change-speed gear case.
F1, transverse casing.
G1, sliding spur wheels—low speed.
G2, sliding spur wheels—intermediate speed.
G3, sliding spur wheels—top speed.
H, H1, H2, H3, spur wheels.
J, water jacketed brake drum.
J1, connecting rods.
J2, foot pedal.
K, hand lever
K1, rods.
K2, slotted quadrant.
K3, slot.
L, hand lever; L1, adjustable rod.
L2, bell crank lever; L3, parallel lever.
L4, pivot; L5, horizontal lever; L6, ends of levers.
L7, pivots; L8, operating rods: L9, side brakes.
M, inclined pillar of steering gear.
M1, steering wheel.
N, water tank.
O, circulating pump.
P1, starting handle.
R, petrol tank, R2, exhaust box.
R3, escape pipe.

single stop, at an average of 30·2 miles for the whole journey, occasionally its speed reaching fifty miles an hour. This was accomplished on a Panhard motor car carrying two persons, weighing one ton, and fitted with a twelve to fifteen horse-power motor.

In the United Kingdom, in 1896, after much agitation, an Act was passed making it legal to drive self-propelled vehicles on the public roads without their being preceded by a man carrying a red flag, and removing many other ridiculous regulations which were still in force. Immediately a vast motor industry sprang up in the country, and petrol motors were employed to propel every form of luxuriously fitted carriage, private omnibus, sporting car, light delivery van or lorry.

In the next year the Automobile Club of Great Britain and Ireland, which has done so much to forward the progress of the automobile in this country, was formed. From that time onward the motor industry has progressed by leaps and bounds.

Modern petrol motors are exactly similar in principle to the much older gas engine, in which the sudden and rapid combustion (or explosion) of a mixture of coal gas and air in the cylinder causes the air to expand enormously, thus forcing outwards the movable piston by which the cylinder is closed.

In places where coal gas is not available oil engines are frequently used. In these the coal gas is replaced by the vapour of petroleum, and attempts are constantly being made to use

petroleum (or paraffin) or other heavy oils for automobile engines. Petroleum, however, can only be vapourised at a very high temperature, and has other disadvantages, as, for instance, the smell which accompanies its use and the rapidity with which it clogs the cylinders with deposit.

For the great majority of automobile engines (and for aeroplanes and all purposes where a light high speed internal combustion engine is required) the motive power is derived from petroleum spirit, or petrol, which is distilled from paraffin. Its chief drawback, as compared with paraffin, is the much greater danger of fire owing to the ease with which it gives off inflammable vapour.

Opening into a cylinder are two valves, the inlet and the exhaust valves, which normally are held tightly closed by springs. The mechanism of the engine is so arranged that at the correct moments they are automatically opened and closed. The care and adjustment of these valves plays an important part in the successful management of the engine.

All external combustion engines have to be started by hand (or other external agency). In doing this the piston is first drawn outwards, thus drawing the "carburetted" air (or mixture of petrol vapour and air) into the cylinder through the open inlet valve.

The piston then returns, compressing the gases into the head of the cylinder (the valves now being closed). They now occupy a space equal to something between one-tenth and one-fifth of their previous volume.

As soon as this compression stroke is complete

an electric device produces an electric spark inside the cylinder head, exploding the charge. The piston is then forced outward, making the third or working stroke. When it reaches its limit the exhaust valve is automatically opened and the piston returns, sweeping the burnt gases out through the open valve. The next outward stroke draws in a fresh charge, and the cycle is repeated.

It will thus be seen that a working stroke occurs once in every four strokes of the piston, the momentum imparted to the engine by the working stroke carrying it on for the next three strokes. This is known as a four cycle, or Otto cycle engine, having been brought into practical use by Dr N. A. Otto, and is the method generally adopted. A two cycle engine, in which every outward stroke of the piston is a working stroke, is sometimes used, particularly for American motor launches.

The first carburettors, as used on all the early motor cars, were of the "surface type." In these a current of air was drawn over the surface of the petrol in the carburettor, the surface being automatically kept at a constant level. The air thus became charged with petrol vapour. This type had many drawbacks. The constant splashing caused the quality of the mixture to be always altering, and the lighter constituents of the petrol evaporated quickly, leaving the heavier or "stale" portion. In modern forms a jet of petrol is sprayed against a conical surface. At the same time a stream of air is drawn through, and by this means a mixture constant in quality is obtained.

The amount of air in the mixture is usually regulated automatically, but in many engines an additional air inlet, controlled by hand, is provided, as an exact adjustment of the proportions of air and vapour in the mixture, varying with the engine speed, the state of the atmosphere and many other considerations, is necessary for efficient and economical working.

A suitable charge having been drawn into the cylinder and compressed, we will now consider the means of ignition. On the earliest motor cars this was effected by allowing the gas to enter a heated platinum tube raised to white heat by an external flame. This was soon discarded owing to the danger of fire, and electrical methods are now universally employed.

An electric spark is made to pass between two insulated metal points (the arrangement being known as a sparking plug), screwed into the cylinder head.

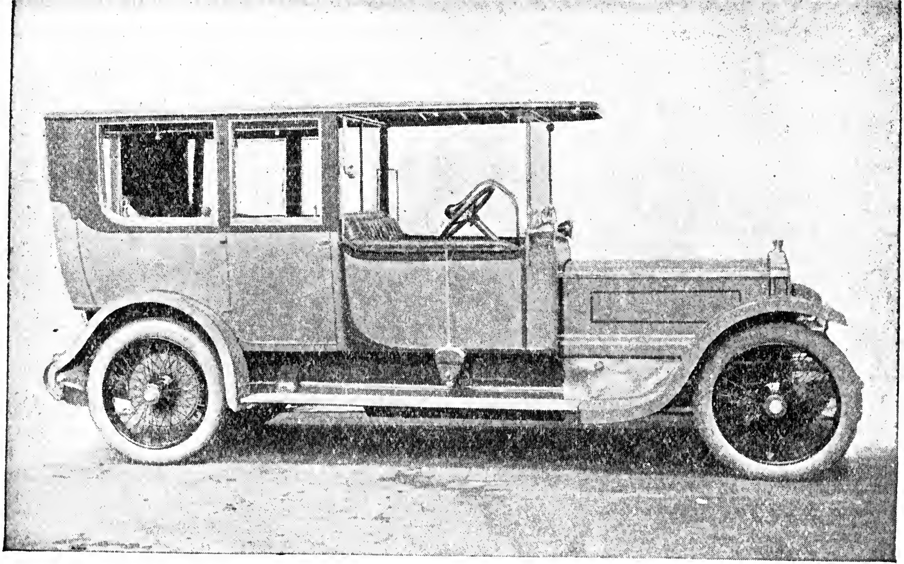
The necessary electric current may be provided either by a dry cell, a storage battery, or a "low-tension magneto-generator" in conjunction with an induction coil. Just as the engine is completing its compression stroke the current passes through the primary circuit of the induction coil, producing a high-tension current in the secondary circuit (which is joined to the sparking plug in the cylinder), and a spark jumps the gap.

In another system a magneto-generator so constructed as to produce a high-tension current direct without the intervention of an induction coil is employed. This is extremely simple and

reliable, but has the disadvantage that the engine must always be started by hand, which, with some forms of battery ignition, is frequently not necessary. Many cars are fitted with both systems.

As may be imagined, the continual succession of explosions (at full speed there are often over 1200 per minute) would soon render the engine excessively hot, so that means of cooling have to be employed. This is effected by surrounding the cylinder with a hollow cast-iron jacket, through which a stream of water is kept constantly circulating, usually by means of a small pump. The heated water passes from the cylinder to a radiator in the front of the car. The radiator may be described as practically a long series of tubes, presenting a large cooling surface for the atmosphere to act upon. The rush of air as the car progresses (often assisted by a revolving fan placed behind the radiator) rapidly cools the heated water, which passes back again to the water jacket. Thus a constant flow is kept up, and the engine remains cool.

The speed of the engine is controlled by a valve regulating the amount of the charge taken into the cylinder from the carburettor; by varying the proportions of gas and air in the mixture; and by advancing or retarding the ignition. There is a particular moment in the cycle when the explosion in the cylinder has a maximum effect. If ignition is delayed so that the explosion only occurs when part of the working stroke has been completed, there is considerable loss of power, and a slower speed results.



THE LATEST TYPE OF DAIMLER CAR (1913 MODEL).

Power may be increased by increasing the size of the cylinder, but in practice it is found better to increase the number rather than the size of the cylinders. Two, three, four, six, and in racing cars even eight cylinders are employed, the most usual number being four. They are so arranged that the working strokes occur in regular succession, and smooth, steady running is thus obtained. Multi-cylinder engines have many advantages over single cylinder motors in addition to smoothness of running, as, for instance, ease of starting and control.

One noticeable point in the general development is the marked increase in the power of engines employed. Levassor's car, which won the Paris-Bordeaux race in 1895, was fitted with a four horse-power engine. Nowadays, engines of 15, 20, 30 or 40 horse-power are commonly used for touring cars, whilst racers are frequently provided with monster engines of 80 or 100 horse-power.

The most important development in engine construction during recent years has been the invention by Mr Knight of the sliding sleeve valve, first brought into practical use by the Daimler Company. The usual mushroom-shaped, spring-controlled valves are replaced by two sleeves which slide between the cylinder and the piston. These sleeves have ports (or openings) cut in them, which are arranged so as to coincide with the inlet and exhaust openings at the correct moments. An unusually silent engine is thus obtained of which great things are predicted.

The power from the engine is transmitted (through a clutch and gear box) to the driving wheels of the car by means of either a chain drive or (more frequently) a "live axle" drive. In the early days belts were used, but they are now only employed for motor cycles. Chain drive is the simpler form, the chain being similar to, but much larger than the chains used on bicycles. In the other system the power passes direct from the gear box through a long shaft (the "cardan shaft") under the centre of the car to the back axle, which rotates with the wheels (hence "live axle"). To allow for the difference of speed of the two driving wheels in turning corners, the axle has to be constructed in two parts, which are driven by the cardan shaft through an arrangement of gear wheels known as the "differential gear."

The clutch usually consists of a tapered, leather-faced projection on the forward end of the driving shaft, which normally is pressed tightly into the inside of the engine fly-wheel by means of powerful springs, so that the shaft and fly-wheel turn together. When it is desired to stop the transmission of power to the wheels without stopping the engine, the clutch may be withdrawn by pressing a pedal.

On most cars the speed of the engine is so arranged that, when travelling at an ordinary pace, there is a direct drive from the clutch to the differential without the interposition of any gear wheels. For hill climbing and for starting from rest, when the car is travelling slowly and it is desirable that the engine should run at full

speed to develop its full power, a series of gear wheels, enclosed in an aluminium gear box, are brought into play. By means of a lever various gear wheels may be made to engage with each other, and so two or three variations may be obtained in the ratio of the speed of the engine to the speed of the driving wheels. Another train of gear wheels in the gear box allows of a reversing motion.

For the control of the car the driver is provided, in addition to the clutch pedal and gear lever, with a foot brake and hand brake, and usually an "accelerator pedal." By pressing the latter the throttle is opened wider, thus admitting more gas to the cylinders and increasing speed and power. On most cars there is a lever for advancing the spark, as already described, and sometimes another for regulating the supply of air to the carburettor. The battery and induction coil (when fitted), and some arrangement for controlling or watching the efficient lubrication of the engine (on many modern cars a constant circulation of oil is kept up by means of a pump), complete the apparatus usually fitted to the dashboard of the car, and immediately under the control of the driver.

Perhaps the weakest spot in a modern car is its pneumatic tyres. Many attempts have been made, so far unsuccessfully, to invent a non-puncturable tyre. To avoid the necessity of repairing a damaged tyre on the road many clever devices are in use. Detachable rims or detachable wheels are frequently fitted, or spare wheels or rims, which may be readily attached to the damaged wheel, are carried.

Although in much more general use, the petrol motor has not entirely supplanted the steam-driven car. The latter is more costly to run, but has certain advantages. It is very smooth running, is easily controlled, and is an excellent hill climber. Moreover, no speed-changing gear is required, as the necessary speed variation may be obtained by a throttle valve, and the engine does not lose power at low speeds. The engine, too, may be readily reversed, so that reversing gear is unnecessary.

In a modern steam car the supply of fuel and water is almost entirely automatically controlled. A steam generator of the "flash" type is used instead of an old-fashioned boiler. This type of generator is due to M. Serpollet, who first experimented with it in 1888. At each stroke of the engine a small quantity of water is injected into a heated coil, and is there instantaneously converted into steam. A great advantage of the steam car is that paraffin instead of petrol may be used as fuel. Steam cars are especial favourites in America.

Of all forms of self-propelled vehicles the electric carriage is the quietest, smoothest running and most cleanly. The weight of the batteries required, the comparatively short distance that can be attained without recharging, the difficulty of obtaining an electric current for recharging except in large towns, and the length of time required for this operation, have so far prevented the electric car being used for any other purpose than as a town runabout, for which use it is pre-eminently suited. One or two

electric motors, connected to the driving wheels by a chain or gear wheel, are connected to the whole or part of the battery, according to the speed required, by the controller.

Great things were expected of the new Edison or nickel-iron battery when it was introduced some years ago. Although a manifest improvement, it has not as yet rendered the electrically propelled vehicle as popular as was anticipated. Instead of prepared lead plates dipping into dilute sulphuric acid, the Edison battery consists of plates of nickel and iron immersed in a solution of potash. Although a larger number of cells are required, the whole battery is lighter and more efficient than a lead battery. A nickel-iron battery weighing 820 lbs. will do the work of a lead battery weighing 1440 lbs., so that with the same battery weight the new battery will carry an electric car nearly twice the distance previously possible without recharging. The new battery requires less attention and is cleaner than the old, and the potash solution only requires renewing about once a year. Its cost, however, is against it, for expensive as is the lead battery, the Edison battery costs fifty per cent. more. It is certainly a step in the right direction, but the world is still awaiting, for this and for many other purposes, the discovery of a light, cheap and efficient storage battery. There is a huge fortune awaiting its lucky inventor.

In 1900 the first race for the international trophy offered by the Automobile Club of France was held. It was won by M. Charron on a Panhard car, who covered the course at the rate

of $38\frac{1}{2}$ miles per hour. The next year the Gordon-Bennett trophy was again won by a Panhard car; but in 1902 Mr S. F. Edge with his Napier car captured it for England with a speed of thirty-four miles per hour. The following year there was a considerable increase in speed, the race being won by the German Mercedes at an average speed of over forty-nine miles per hour. The next two years the trophy was captured by French cars.

After 1905 the Gordon-Bennett race was discontinued, and for the next three years the *Grand Prix* was held instead. Another increase of speed took place, the pace of the winning cars for the three years being sixty-three, seventy and sixty-two miles per hour respectively.

The year 1907 was an important one in the development of motoring. It was in this year that the Brooklands track, near Weybridge, was opened. This was the first specially constructed automobile track in the world, and provided opportunities not only for racing, but for extended tests of cars such as had never before existed. On the new track Mr S. F. Edge made a time record, which has never been beaten, by driving 1581 miles 1310 yards in twenty-four hours, an average of 65·9 miles per hour.

In the same year a severely practical test was held, when three cars set out from Peking to travel across the Goli Desert, Siberia, Russia and Germany to Paris. They started on 10th July, and on 10th August Prince S. Borghesi on a forty horse-power Itala car reached Paris.

In the following year a still longer test was carried out, three cars starting from New York,

travelling across America to the Pacific coast, where they were shipped to China, and from there repeating the course of the previous year. A Protos car was the first to arrive at Paris on 26th July, 164 days after leaving New York.

The highest speed ever accomplished in an automobile is 127·877 miles per hour, which is the rate at which Hemery covered half a mile from a flying start at Brooklands in 1909. This only just exceeds the previous record of 127·7 miles per hour made in 1906 by Marriott at Ormond Beach, where he covered a mile at this high rate of speed. The mile record from a standing start was also made at Ormond Beach in the same year by Macdonald, his speed being 96·3 miles per hour.

During recent years the attention of designers has been turned to the production of automobiles that are reliable and comfortable under ordinary touring conditions, quiet and economical in working, rather than to the manufacture of these track racing monsters, in which everything is sacrificed to speed. The speed of the modern car has reached its limit for all practical purposes, and it is unlikely that many fresh records will be made, at least for some years to come.

The rapid increase in the use of self-propelled vehicles after the passing of the Act of 1896 rendered necessary the Motor Car Act of 1903, which imposed a speed limit of twenty miles an hour on all cars driven on the public roads, established a system of compulsory registration of all cars in the United Kingdom, made it

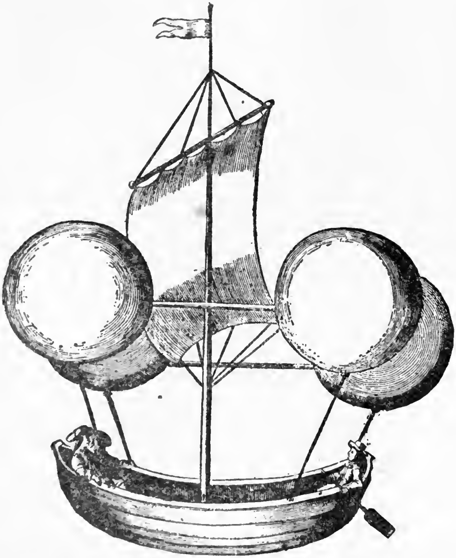
necessary for all drivers of self-propelled vehicles to hold a licence, and enacted various other regulations for the safety of the public.

In 1910 a tax of threepence a gallon was placed on petrol, and the duties on motor car licences were increased in accordance with the recommendations of a Royal Commission. The Commission also recommended the abolition of the speed limit except for villages and small towns, where a limit of twelve miles per hour (which already exists in many dangerous places by order of the Local Government Board, under powers given them by the Act of 1903) was advised. At present this recommendation has not been made law.

## CHAPTER IX.

In the whole story of locomotion nothing is more remarkable than the history of man's attempts at flight. For a thousand years or more the problem seemed impossible of solution. Nevertheless, Franklin, speaking of the science of aeronautics, declared, "It is an infant, but it will grow." Long after Franklin's day it seemed as though the great scientist's prophecy would never be fulfilled. For many years the infant refused to make any perceptible progress. It was not, indeed, until the opening years of the present century that human flight was finally proved to be within the bounds of practical possibility. Now, however, the many years of

patient experimenting without apparent result are having their effect, and the art of flying is bounding forward at a more than astonishing pace.



AN AIRSHIP DESIGNED BY FRANCIS LANA OF BARCELONA, 1670.

That all the efforts of the many clever men who attacked this ancient problem for so long came to naught, was due as much to the fact that general engineering science was not sufficiently advanced as to the want of understanding of the aeronautical problems involved. Only when the

development of the petrol motor provided a convenient source of power without the necessity of carrying excessively heavy and cumbersome machinery was the road to success thrown open.

Even now there are many problems to be solved and many difficulties to be overcome. It may be that we are still only at the beginning of the science of flight, and that some entirely new form of machine may be invented which will surpass in wonder the performances of the ever-surprising aeroplane.

The earliest recorded attempt appears in the Ministre's History of Lyons: "Towards the end of Charlemagne's reign, certain persons who lived near Mount Pilate, in Switzerland, knowing by what means pretended sorcerers travelled through the air, resolved to try the experiment, and compelled some poor people to ascend in an aerostal. This descended in the town of Lyons, where they were immediately hurried to prison, the mob desiring their death as sorcerers. The judges condemned them to be burned: but the Bishop Agobard suspended the execution, and sent for them to his palace that he might question them."

When the good prelate had heard their tale of the singular manner in which they had travelled so far in so incredibly brief space of time, he pardoned them, although himself incredulous. Posterity, which reads this story, may likewise share the bishop's incredulity. Francis Lana of Barcelona was said to have invented an aerial machine in 1670, but it failed to travel: wherefore we may wisely pass over a host of similar

relations, as well as all the aerostatic experiments up to the invention of the balloon by the brothers Montgolfier in 1783.

Nearly ten months had elapsed since this first aerostatic experiment, when a young chemist, Pilatre de Rozier, offered himself as the first voyager in the newly-invented aerial machine. The first to make an aerial voyage (in the horizontal sense) in England was a Neapolitan, Vincent Lunardi: on the 15th September 1784, he travelled from the Artillery Ground, Moorfields, to Standon, near Ware, Herts, a distance of 30 miles. The journey was not remarkable for speed, as it occupied two hours and a quarter, including a stoppage at South Mimms. "The departure was most exciting." "Perhaps," observed the *Morning Post* of the following day, "the English nation never witnessed upon any occasion whatever such a number of persons collected together and so loftily displayed; not a plain or an eminence, a window or a roof, a chimney or a steeple but were prodigiously thronged." Lunardi became a popular hero, was presented to the King, and made a honorary member of several learned societies.

Four days later, in Paris, the brothers Robert performed a journey in the air from Paris to Arras, 150 miles, a portion of the trip being made at the rate of twenty-four miles an hour. This journey is remarkable as being probably the fastest ever made by human beings for such a distance, up to that era.

But this record of speed was soon to be broken. Sadler, an English aeronaut, ascended

AN EARLY AERIAL VOYAGE.

from Oxford on the 12th October of the same year, going fourteen miles in forty-one minutes, descending, and after considerable delay, proceeding to Romsey, in Hampshire, at the rate of twenty-nine miles an hour.

A memorable aerial voyage—the first across the English Channel—took place on 7th January 1785. Blanchard, a Frenchman, and Dr Jeffries, an American, pushed off in a balloon from the cliff at Dover at 1 P.M. The weight being too great for the power of the balloon, some time was consumed in discharging ballast. When they rose, they continued vertically, so that properly the journey did not commence until half-past one. Exactly at three o'clock, after an exciting voyage, during which they had been obliged to throw overboard their very clothes, they passed over the high ground midway between Cape Gris Nez and Calais. They descended in the Forest of Guines. The freedom of Calais was bestowed upon Blanchard, and a monument erected to mark the spot where the pair alighted.

It was in an attempt to emulate this exploit that a few months later Pilatre de Rozier and his friend Romaine lost their lives.

The maximum of speed had not yet been attained—and Lunardi, on 5th October 1785, was to surpass his own record and all of his contemporaries. Rising, at 3.45 P.M., from Heriot's Gardens, Edinburgh, he says: "The city of Glasgow I could plainly distinguish, also the town of Paisley, and both shores of the Forth; but my attention was now diverted by

finding myself immediately over the Firth of Forth, at an altitude of 2000 feet. . . . At 4.20 I descended at Ceres, after a voyage of forty-six miles, thirty-six being over water, and was conveyed in triumph to the town of Cupar." Thus Lunardi had accomplished forty-six miles in thirty-five minutes, which is a speed almost equalling the fastest that has ever been done on a railway. A longer journey was subsequently done by Lunardi, leaving Glasgow at 1.55 P.M., and in precisely two hours arriving at Alemoor, Selkirkshire, 110 miles, including a halt of some minutes in the hills.

A voyage notable for its remarkable rapidity was executed by Garnerin, June 28, 1802, in company with Captain Snowdon, R.N. They departed from Chelsea Gardens and came down near Colchester, sixty miles in forty-five minutes. On the 5th July, Garnerin ascended from Marylebone and descended at Chingford, seventeen miles, in fifteen minutes, and attained also during this interval a height of 7800 feet.

But a more notable voyage was to be made by the French aeronaut Garnerin, in the balloon commemorating the coronation of Napoleon I. At 11 P.M. on the 16th December 1804, Garnerin allowed his colossal machine to rise from the square in front of Notre Dame, Paris. Twenty hours later it had passed through France and Italy, over St Peter's at Rome and the Vatican to descend into Lake Bracciano. It had traversed a distance of 800 miles. The coronation balloon was subsequently suspended in a corridor of the Vatican, where it remained until 1814.

No further notable aerial voyages are recorded until October 7th, 1811, when Sadler and Burcham left Birmingham at 2.20 P.M. and by 4 P.M. had made a flight of 112 miles. They finally alighted near Boston, *via* Leicester, Market Deeping and Peterborough.

Sadler was the first to attempt to cross the Irish Channel, ascending from the lawn of Belvedere House, Dublin, 1st October 1812, and receiving his flag from the Duke of Richmond. But he found himself precipitated into the sea *en route*, the feat not being accomplished until 1817, when the same aeronaut's son, Windham Sadler, travelled from Portobello Barracks, Dublin, at 1.20 P.M. on June 22, and at 6.45 alighted a mile south of Holyhead.

Soon after this the famous Charles Green begins his long series of intrepid aerial journeys, many of which were remarkable for distance and speed. One of these was undertaken in a storm, from Newbury, Berkshire, to Crawley, Surrey, fifty-eight miles, in an hour and a half, which was rapid time for 1827, considering that the one railway then in England could only boast of twenty miles an hour. But by far the greater portion of Green's fame must rest upon his voyage from London to Weilburg in the great Nassau balloon. This took place in 1836, the start being from the Vauxhall Gardens at 1.30 P.M., November 17th. At twelve minutes to three the Medway was crossed, and Canterbury at five minutes past four. A curious circumstance is that the aerostat passed several coaches *en route*, going at the fastest rate possible,

and was cheered by their occupants. The railway was not then opened, and the fast time to Canterbury by coach was five and a half hours. At 4.48, Green (who was accompanied by Monck Mason) gained the Channel, and at ten minutes to six o'clock had effected a crossing in safety, two miles from Calais. As the night progressed they were, of course, totally without landmarks and so could not judge of their speed. "In this manner," writes Mason, "did we traverse with rapid strides a large and interesting portion of the European continent, embracing within our horizon an immense succession of towns and villages, whereof those which occurred during the earlier part of the night, the presence of their artificial lights alone enabled us to distinguish."

It was at 7.30 on the following morning that the descent took place, so that the duration of the voyage was exactly eighteen hours. "The first question, 'Where are we?' was speedily answered, 'In the Duchy of Nassau, about two leagues from the town of Weilburg.' The second was theirs, 'Where do you come from?' 'From London, which we left yesterday afternoon.' The astonishment of the inhabitants at this declaration may be imagined."

To reach Weilburg from the British capital in the year 1836 by the fastest coaches and steamer would have taken three days. Green and Mason had done it by balloon—a distance of over 500 miles—in eighteen hours. A considerable portion of five kingdoms, England, France, Belgium, Prussia and the Duchy of Nassau; a long succession of

cities, including London, Rochester, Canterbury, Dover, Calais, Cassel, Ypres, Courtray, Lille, Oudenarde, Tournay, Brussels, with Waterloo and Jemappes, Namur, Liége, Spa and Coblentz were all brought within the compass of their horizon. When one reflects on the smoothness of the travelling, its quiet and absence of distracting apparatus, we may safely regard this long journey as an ideal transit and among the most remarkable for speed which ever took place prior to the establishment of railways.

In June 1841, Wise, an American aeronaut, set out from Danville, Pa., at 2.35 P.M., and arrived at Morgantown, seventy miles distant, at 4.25, having in reality travelled a tortuous course at the rate of fifty-five miles an hour. In the same year Green travelled twenty miles in twenty minutes from Chelsea to Rainham, Essex. A few years later Coxwell travelled through the air from Berlin to Dantzic, 270 miles, in three hours and ten minutes.

A remarkable instance of speed in aerial transit was afforded in 1849 by M. Arban, who crossed the Alps from Marseilles to Turin, a distance of 400 miles in eight hours. This record between the two cities has never been broken. The speed, however, was equalled in Coxwell's journey in 1857 from North Woolwich to Tavistock, Devon, 250 miles, in five hours. "It was some time before the particulars of the journey obtained credence. At Sidmouth the alarm-bell was rung by the night watchman; but before the inhabitants were astir the balloon was out of sight and the man laughed at, until the

Devonshire papers were published with an account of the voyage." The aeronauts walked into the town of Tavistock, and put up at the Queen's Hotel, where they had difficulty in persuading the worthy host that they had been in London the night before. A shorter journey from Winchester to Harrow, seventy-six miles, was in 1862 accomplished in sixty-six minutes by Colonel M'Donald and six officers of the Rifle Depôt Battalion, accompanied by Coxwell. For most of the voyage the velocity was not less than seventy miles an hour.

We now come to one of the most celebrated of modern balloon voyages, that of Nadar's "Géant" in 1863 from Paris to Nienburg, Hanover. This famous journey was preceded by a brief one on the 4th October, in which no fewer than fifteen persons were carried in the monster car. The balloon held 6098 metres of gas enclosed in 20,000 metres of silk, and was the largest ever constructed. It descended on this occasion two leagues from Neaux, and a fortnight later, with nine passengers, reascended at 5 P.M. from the Champ de Mars. At half-past eight it was over Compiègne, seventy-eight miles from Paris. Nothing more was heard of the balloon until a second telegram was received in Paris stating that Nadar's giant balloon passed over Erquelines, on the Belgian frontier, at midnight on Sunday. The airship was moving not far from the ground, and the customs officer called out to know if there was anything on which duty should be paid! No attention was paid to the question, and the balloon kept on its way towards the

German frontier. At midnight the travellers were over Holland, and later crossed the Zuyder Zee. At 7.15 they were journeying through Westphalia, crossing the river Ems, and at length returning to Hanover, a little above Osnaburgh. The balloon was on its way towards Hamburg and the Baltic when it was thought wise to effect a descent.

The descent was of a most exciting and desperate character, for the wind was blowing at a high rate, and the balloon was moving through the air at sixty miles an hour. The car grazed the earth and began dragging over walls, fences, houses, stones and ponds. One of the passengers, Jules Godard, then tried to accomplish an act of sublime heroism. He clambered up into the netting, and although three times falling, reached the cord of the valve, opened it, and the gas having a way of escape the monster ceased to rise, but it still shot along in a horizontal line with prodigious rapidity. One after another the passengers jumped, not without injury, from the car, and soon found that they had arrived in the vicinity of Rethern in Hanover. In seventeen hours they had travelled 250 leagues, while for a single hour they had sustained a speed of at least ninety miles.

The siege of Paris offered to the professors of aerial navigation a signal opportunity to apply their system.

At the outbreak of the Franco-Prussian war in July 1870 there were in Paris many experienced aeronauts, including Tissandier, de Touvielle, Nadar, Jules Durouf (about whom we shall speak

later) and Eugène Godard—who had made no fewer than 800 ascents. The subject of military ballooning was naturally raised, and received a lukewarm support from the Imperial Government, which was far too disturbed seriously to consider any scientific matter, even the true science of the commissariat in war-time. Before anything could be arranged, there came the disaster of Sedan, which was followed in a few days by the close investment of Paris. The new Government at once addressed themselves to the aeronauts, with a view to opening up aerial communication with the exterior country. Six balloons were overhauled, all in indifferent condition, the worst being the one Napoleon III. had intended for Solferino, but which had arrived on the scene of the battle a day too late. M. Tissandier tells us that nobody seems to have known how to repair this balloon, known as *L'Impérial.* However they were all got together, the besieged Parisians hailing the prospect with the joy of children. Here at last was a noteworthy chance of putting into execution the very idea for which Montgolfier, the inventor of the balloon, had really intended his invention.

The first ascent of the siege was made by M. Durouf on September 21st. He carried a large number of despatches, and after a three hours' journey landed safely near Evreux. He was followed on the 23rd by M. Mangin; on the 29th by Godard, jun., and on the 30th by Gaston Tissandier, who has given us a spirited account of his voyage.

The success of these aeronauts in escaping

from the capital and the hands of the Prussians encouraged the Government to establish a balloon post on a regular system. Immediate steps were taken for the manufacture of a large number of balloons, under specific conditions, as rapidly as possible. Making the vessels proved, however, an easier task than finding captains for them. Experienced aeronauts were few, and it must be remembered that when once they left Paris there was no returning. That was the radical fault of balloons; one could not elect the place of one's descent. In this emergency it was decided to invite the assistance of such sailors as there were in the capital, as belonging to a class whose training had rendered them familiar with operations and dangers not dissimilar from ballooning. The appeal met with a satisfactory response; many excellent mariners offered their services; they were given all possible instructions, and a large number of successful ascents were carried out by these brave French tars. The remark of one of them deserves to be memorable. "Our topsail is high, sir, and difficult to reef; but we can sail, all the same, and, please God, we'll arrive in port."

The plan of employing acrobats from the Hippodrome was attended with less success. In several instances we are told they directed their skill, when in a tight place, to slip down the guide rope to earth, leaving the passengers and despatches to look after themselves. But on the whole the balloon service was distinguished by singular ability and precision. From September to January sixty-four balloons were sent off,

and of these fifty-seven fulfilled their mission, and the despatches reached their destination. The total number of persons who left Paris was 155, the weight of the despatches was nine tons, and the number of letters 3,000,000. As for the speed of transit, it varied from twenty to fifty miles an hour, and in one instance as high as eighty miles.

Gambetta left by the *Armand Barbes* (every balloon had of course a name) on the 7th October. When at too low an altitude he was immediately fired on by the Prussians and narrowly escaped being hit by a bullet.

On the 27th October the *Bretagne* fell, owing to bad management, into the hands of the enemy near Verdun; on the 4th November the *Galilee* had a similar fate near Chartres; and on the 12th the *Daguerre* was shot at, brought down and seized a few leagues from Paris. The loss of three balloons within a little more than a fortnight alarmed the Government. It was obvious that the vigilance of the enemy had been aroused, and whenever a balloon was seen advices were telegraphed along its probable line of flight, and the swiftest Uhlans were put on the alert in the hope of capturing it. The danger had vastly increased, since a new rifled gun of enormous range had been made by Krupp for the purpose of firing shells at the aerial transports. One of these was about this time set up at Versailles. For these reasons the Government resolved that in future balloon departures should take place at night. At the same time the darkness added greatly to the difficulties of the voyage, and

several of these nocturnal ascents were attended with singular adventures.

About midnight, on the 24th November, the *Ville d'Orléans* rose from Paris with an aeronaut and one passenger. The wind blew from the north and it was hoped the balloon would descend near Tours. But in a short time the voyagers heard a sound below them which caused them both deep apprehension; it was the lashing of breakers on the shore. At the time of this discovery they were in a thick mist; when at daybreak this cleared they found themselves suspended over the sea, out of sight of land. Several vessels were perceived and to these they tried to signal, but were not answered. One vessel, indeed, responded; but it was by firing at them. Scudding now rapidly to the north they were giving themselves up for lost when they came in sight of land to the eastward. Before they could gain it they descended rapidly from loss of gas: their ballast being gone they were obliged in despair to throw out a bag of despatches. This expedient saved them; the balloon rose, encountering a westerly current which carried them to shore. What part of the world they were in at their descent they had no notion; the ground was covered with snow, they saw no inhabitants, and being overcome with fatigue and hunger, both fainted on getting out of the car. On recovering they walked through the snow with great exertion, and after a painful journey of several hours passed the night in a shed. In the morning a couple of woodmen informed them, by means of signs and a box of

matches marked Christiania, that they were in Norway. Their speed was over fifty miles an hour for a number of hours.

A week later, on the 30th of November, two fateful ascents from beleaguered Paris were made. The *Jacquard* rose at 11 P.M. in charge of a sailor named Prince, whose new found aeronautic zeal was so great that as the ropes parted he cried out: "Je veux faire un immense voyage; on parlera de mon ascension." He was not, alas, to be baulked of his ambition. Driven by a south-easterly wind he passed over the English Channel where he was seen by some English vessels. While over the vicinity of the Lizard he dropped his despatches, some of which were afterwards picked up on the rocks. Thus lightened the balloon rose to a great height, disappeared over the Atlantic billows and was never heard of again.

The second balloon, the *Jules Favre*, started at half-past eleven with two passengers. Only by a miracle did it escape the fate of the *Jacquard*. The wind blew from the north, and the aeronauts fancied they were on their way to Lyons. Long enveloped in fog, they emerged at daybreak and saw beneath them an island which they supposed to be in a river. They were grossly deceived; it was Hoedic, in the Atlantic! They were driving furiously out to sea; but in front of them lay, as a forlorn hope, the larger island of Belle-Isle. It was seen that they would have to pass one end of it where it was very narrow, and that they must either land on this strip of land or be lost. They tore the valve open with frantic

energy, caused the balloon to descend some 1000 feet in a few minutes, and luckily succeeded in striking the land. Albeit the shock was terrific; three times did the balloon bound into the air, and at last caught against a wall, precipitating the occupants of the car to the earth. They were badly injured, but received great attention from the people of the neighbourhood. The father of General Trochu resided there, and ordered them to be brought to his house.

On December 15th the *Ville de Paris* was so unlucky as to fall at Wertzlar, in Prussia; and four days later the *General Chanzy* was made captive at Rothenburg, in Bavaria. On the morning of 28th January, the *Richard Wallace*, which rose from Paris the previous night, was observed at La Rochelle approaching the sea and almost touching the ground. The people shouted to the aeronaut to descend, but instead of doing so, he threw out a sack of ballast, rose to a great height and soon disappeared in the western horizon. Doubtless, the poor fellow had lost his senses on seeing the danger which confronted him. This almost completes the story of the ballooning during the siege of Paris. It was the last ascent but one; that on the next day bore intelligence to the Provinces of the conclusion of an armistice.

These aerial voyages had solved the problem of communication from Paris outwards. The other problem of communication inwards from the Provinces was hardly less important and much more difficult. It required a particular direction of current, and although M. Tissandier

made several attempts he failed, and the return of the balloons was abandoned as impossible. Of the projects which were offered to the Government to encompass the desired end, some were among the wildest and most visionary that ever entered the brain of man. One balloon took out some trained dogs, which, it was hoped, would find their way back again, but they never reappeared.

The actual method by which the difficulty was solved deserves, we think, a place in a work dealing with modern locomotion. The return post was effected by means of carrier pigeons, which, having been taken out of Paris in balloons, were let loose in the Provinces to find their way home. There existed in Paris a "Société Colombophile," and after the departure of the first balloon the leading spirits of this body approached General Trochu, and proposed that an attempt should be made to combine the outward balloon post with a return service by pigeons. The second balloon carried three birds, which came safely back six hours later, with news from the aeronauts. The return of eighteen more despatched in following days confirmed the practicability of the scheme. Thereupon, the service was regularly organised and was carried on with a fair amount of success throughout the investment of the capital by the enemy. As the despatches were required to be very small and light, recourse was had to microscopic photography. By this means sixteen folio pages of print (32,000 words) were reduced to a pellicule two inches long, one and a quarter inches wide,

and weighing about three-quarters of a grain! The messages were destined for residents of Paris, and came from all over France. Here are a few samples:

DÉPÊCHES À DISTRIBUER AUX DESTINATAIRES.

*Pau, 26 Janvier.*—A. Tocher, Rue Chausée d'Antin. Madeleine accouché heureusement hier. Bien beau garçon.

*Biarritz, 1 Février.*—A. Martin, 68 Rue Petites Ecuries. Sommes à Biarritz, bebé complètement remis, embrasse papa, douloureusement impassionés événements.

*A. Tant.*—Besoin d'argent, demande Masquier.

*A. Perier.*—Tout parfaitement bien; trouverons charbon dans cave.

Each pigeon carried twenty of these tiny gelatine leaves, carefully rolled up and placed in a quill. They contained sufficient printed matter to fill a large volume, and yet the weight of the whole was only fifteen grains. When the bird arrived at his cot in Paris, his precious little bundle was taken to the Government office, the quill was then cut open and the gelatine leaves extracted. Placed in an enlarging optical apparatus, similar to a magic lantern, the messages were thrown on a screen, copied from thence, and sent to their destination. The charge was fifty centimes a word. The despatches were not entrusted to one pigeon, but repeated by others, in order to provide against accidents, which were very common. The Prussians were powerless against the winged messengers, although an attempt was made to chase them with birds of prey: but dense fogs and severe cold played havoc with the birds. There were

sent out of Paris 363 pigeons, of which only fifty-seven returned, some having been absent a long time.

Such is a brief narration of this aerial post. It was, beyond question, a marked success. Although it could not save France or her capital, yet it was an immense boon to the besieged, for it established, during the whole of the siege, that communication with the exterior which would otherwise have been impossible. Had the cause of the French been less desperate, the strategic advantage this correspondence would have imparted might have even turned the scale against the enemy.

This suggests to us a reference to the speed attained by pigeons as agents of rapid transit.

The idea that fast homing pigeons cover a mile a minute for a considerable distance must, like the tradition that Eclipse once accomplished that feat, be finally abandoned. In no part of Great Britain are the breeding and training of these birds brought to greater perfection than at Sheffield, and if its champions cannot travel at the pace of express trains or approaching such speed, it is not probable that other localities are better supplied. In a competition early in 1902 from Banbury to Sheffield, a distance of ninety-two miles, nearly 300 birds were flown with a strong wind behind them. All other circumstances being propitious, and the birds being selected for speed from a very much larger number, it was anticipated that the winner's time would be exceptionally fast. Whether that was the case is not recorded, but the official

timing gave the leading bird an average velocity of only about two-thirds of a mile per minute, with several others in pretty close attendance. Some time was lost, no doubt, after the start before the direct line for home was hit on, and also at the finish before alighting. But even when full allowance is made for these delays, it does not go far to make up the difference between 1161 yards and 1760 yards a minute. Still, since very few of the birds liberated at Banbury failed to arrive at their destinations, the pigeon-post presents the additional advantage of a large degree of security. We have seen that when several of these birds were entrusted in war time with the same message, some were sure to reach their destination, even if the enemy were ever so vigilant.

On the conclusion of the Franco-Prussian war, M. Dupuy de Lome, naval architect to the French Government, produced an elongated balloon 120 feet in length and fifty feet in diameter, containing 120,000 cubic feet of hydrogen.

An elongated balloon had been produced as far back as 1784 by a French officer, General Meusnier, who surrounded his gas envelope with an outer envelope, the space between being filled with compressed air. By altering the pressure in the outer envelope he was able to control the lifting power of his balloon. The principle has been adopted in the air balloonets, which are fitted to most modern airships. The method of propulsion was by a number of oars operated by hand. In 1852 Henri Giffard made the first attempt at a power driver aerostat or air-

ship. The propeller was driven by a three horse-power steam engine. Dupuy de Lome reverted to the use of man power, employing a screw propeller made of sails driven by eight men. With it the inventor made a journey of some ninety miles, but without being able to control the direction.

In the same year (1872) Haanlein took an important step in the right direction by constructing an airship in which the power was obtained from a gas engine, but even this was too clumsy and heavy to prove a practical success.

Other similarly shaped airships followed, until in 1884 MM. Krebs and Renard of the French army accomplished for the first time a circular voyage, returning from the point of departure after a considerable aerial flight. Following the example of Tissandier in the previous year, their propeller was driven by an electric motor and, under favourable atmospheric conditions and using a car of extreme lightness, they attained a speed of some six miles per hour.

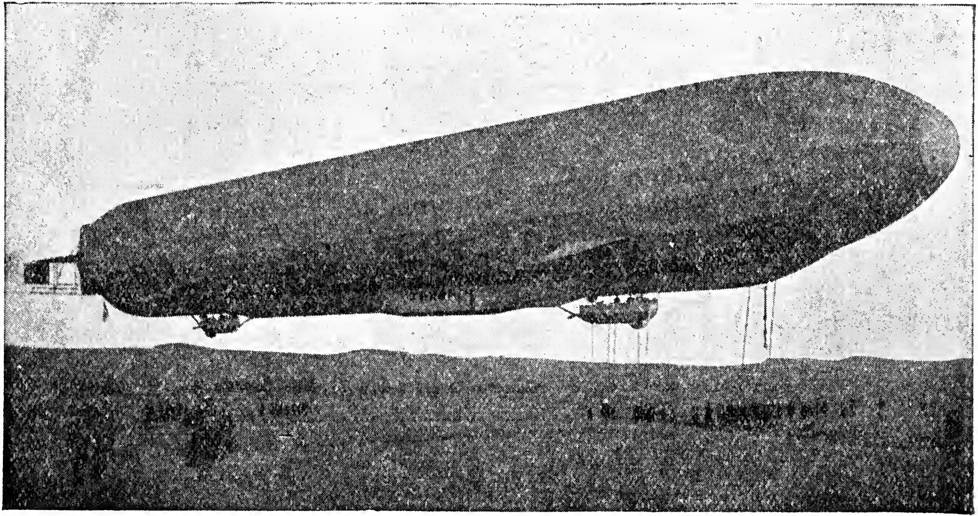
Many of these early attempts might have been comparatively successful had there been some suitable engine available for their propulsion.

It was not until the advent of the motor car had resulted in the construction of the light and powerful petrol motor that a dirigible balloon became a practical possibility. The first attempt to use a petrol motor in an airship was made by Wolfert in 1897, but unfortunately his petrol caught fire when in the air, the ship was blown up and Wolfert and his assistant killed. A similar attempt was made by Schwartz during

the same year, but his vessel was wrecked by wind. A year or so later Santos-Dumont, a young Brazilian, began his experiments in France, which resulted, in 1902, in his winning the

THE TRIUMPH OF SANTOS-DUMONT. HOW HE ROUNDED THE EIFFEL TOWER.

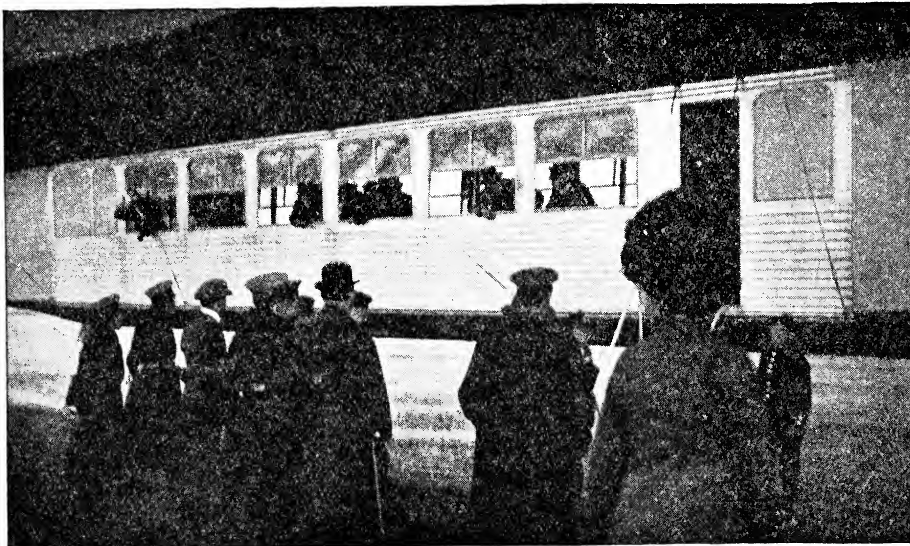
Deutsch prize of 100,000 francs by the circumnavigation of the Eiffel Tower. This result was obtained by the use of the latest pattern of four-cylinder water-cooled petrol motor of twelve horse-power.



THE ZEPPELIN DIRIGIBLE "HANSA," ONE OF COUNT ZEPPELIN'S LARGEST PASSENGER AIRSHIPS.

But Santos-Dumont was not the only experimenter in the field, for about 1899 Count Zeppelin had produced in Germany the first of the series of airships which have since made him world-famous. He adopted the "rigid" type of airship first produced by Schwartz in 1893, the gas envelope being surrounded by an outer casing of aluminium, thus protecting the gas-bag from too sudden temperature variations, and greatly strengthening the whole construction. The gas-bag also was constructed in a sort of bulkhead system, being formed of seventeen different compartments. Many other improvements were introduced, such as the duplication of engines and propellers and the employment of elevating planes and a sliding balance weight. Although a speed of some sixteen miles per hour was soon attained, Zeppelin at first had many failures and received but little encouragement. He persisted, nevertheless, with praiseworthy determination, ultimately receiving assistance from the German Government and public. He is now able to construct airships carrying forty persons for short journeys, or half that number for long distances. There is much mystery as to the capabilities of these enormous air-craft. They are said to have attained speeds of fifty or sixty miles an hour, and to have accomplished, without a descent, journeys of over 800 miles in about thirty hours.

After 1900 a number of airships of different types began to be constructed, some of them quickly resulting in fatal accidents. The production of the Lebaudy airship, which was



THE PASSENGER CAR OF THE "HANSA." (Compare this with the previous illustration.)

gradually improved after several disasters, has been said to mark "the beginning of practical aerial navigation." This vessel, which was purchased by the French Government in 1904 as a model for a French air-fleet, was of a semi-rigid construction, the gas envelope being attached to a keel of metallic tubing. Numerous other airships, mostly of the non-rigid type, in which the car and engines are suspended directly from the balloon itself, have been produced in France. Particularly must be mentioned the huge Clement-Bayard, which on 16th October 1910, under favourable conditions, travelled with seven persons on board from Paris to London, covering the 246 miles at an average of forty-one miles per hour. This huge vessel is 250 feet in length, and carries petrol engines of 250 horse-power. It has since been purchased by the British War Office.

A number of airships have been constructed in Great Britain during recent years both by the Government and by private enterprise, chiefly with a view to their use for military purposes; but it must be admitted that in common with every other nation, except perhaps France, we are far behind Germany in our development of this form of locomotion.

The subject of dirigible balloons must not be dismissed without a reference to the most ambitious experiment ever attempted in this type of vessel — the attempt made by Mr Wellman on 15th October 1910 to cross the Atlantic. This daring aeronaut, who had previously attempted to reach the North Pole by

air, designed a special airship fitted with a lifeboat, searchlights and wireless telegraphy apparatus; but its special feature was a device which he termed the equilibrator, consisting of a trail of thirty floating steel cylinders connected by steel cables. The end of the equilibrator floated on the sea behind the vessel. If from any cause, such as an increase of temperature, the airship began to rise above its normal height, one or more of these cylinders were naturally lifted from the water, and the additional weight tended to keep the vessel always at the same level. But the equilibrator proved its undoing. At first all was successful. Soon, however, the wind began to increase, and in spite of the 160 horse-power engine the ship was blown out of her course. As the waves became rougher the equilibrator was thrown violently about, and its jerky motion threatened to wreck the whole vessel. After the ship had been in the air for sixty-nine hours and had travelled 1000 miles, wireless communication was fortunately established with a passing steamer, with the result that the airship crew were rescued from their lifeboat and their novel craft abandoned.

The most remarkable feature of aerial locomotion has been the marvellous rapidity with which "heavier than air" flying machines (as distinct from dirigible balloons) have suddenly been developed and brought into practical use. Experiments with heavier than air machines were made long before balloons were thought of. The first authentic record dates from the year 67 A.D. In 1060 Ollivier, a monk of Malmesbury,

constructed a pair of artificial wings and, with more courage than forethought, jumped from the tower and was seriously injured. At the beginning of the sixteenth century Leonardo da Vinci, the famous painter, published at Florence a celebrated treatise on flight which displays a remarkable knowledge of the subject. He designed a machine of the helicopter type—that is to say, one with horizontal propellers. Many attempts have since been made with this type of apparatus, but all have been unsuccessful.

It was not until 1809 that Sir George Cayley introduced all the modern theories of flight and prepared the way for all the wonderful successes of recent years by the construction of his "glider"—that is to say, an aeroplane without any propelling power. His invention made many successful flights, but without a passenger. In 1842 John Stringfellow and W. S. Henson designed a practical model aeroplane on Cayley's system.

In 1856 Le Bris, a French sailor, was injured when experimenting with a glider which was drawn, kite fashion, against the wind by a team of horses.

The next event which had an important bearing on the problem of mechanical flight was the invention of the box-kite by Laurence Hargrave, a native of New South Wales. Experiments with box-kites have supplied much useful information, and have had a marked influence on aeroplane design. Otto Lilienthal, a German engineer, in 1889 began a series of valuable gliding experiments, which he continued until he

was killed eighteen years later. (He will always be remembered by the famous book "Bird Flight," which he published with the co-operation of his brother.)

The last difficulty in the way of successful flight, the absence of a suitable propelling apparatus, was by this time being overcome by the rapid development of the petrol motor, the power producer which has made, and is still making, such a wonderful difference in all our modern methods of locomotion.

On 9th October 1908 Clement Ader made in France the first short and successful power-driven flight. Two years later the brothers Wilbur and Orville Wright, who had made many gliding experiments in America, followed their example, using a petrol motor. By 1905 their machine had so far progressed that Wilbur Wright was enabled to make a flight of eighteen minutes' duration. Three years later his brother remained in the air for two hours twenty minutes twenty-three seconds, during which time he covered 77½ miles.

Meanwhile many other experimenters were at work, and the result of their efforts rendered future progress rapid. Researches into the difficult question of air resistance, the science of aerodynamics, were carried on for many years by Prof. Langley in America, M. Eiffel in France, and Prof. Dines and Sir Hiram Maxim in England, and progress was thereby much facilitated. From the time of the first public flight made by Santos-Dumont in 1906 the science

of aviation has bounded forward at an annually increasing pace. In 1908 H. Farman made the first circular aeroplane flight, and a few months later carried a passenger for the first time.

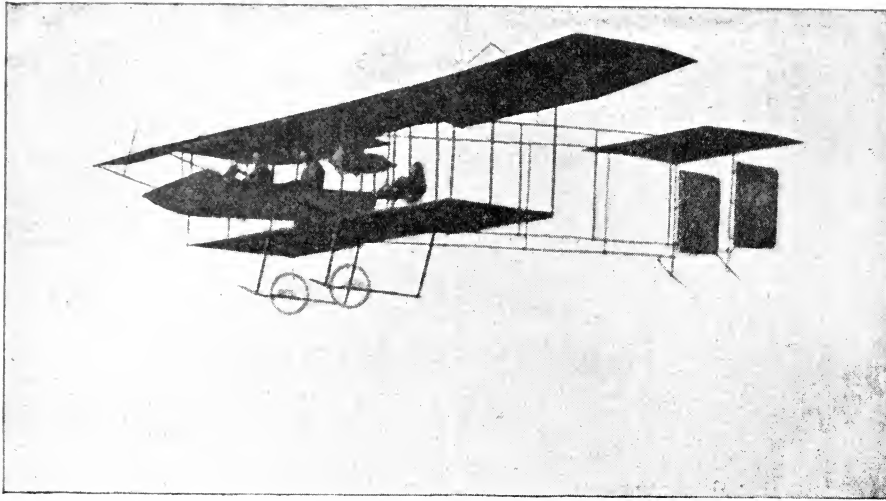
On 25th July 1909 M. L. Bleriot flew across the English Channel, thereby winning a prize of £1000, and in the same year Farman proved the practicability of the new method of locomotion by carrying two passengers a distance of about $6\frac{1}{4}$ miles. On 28th April 1910 Louis Paulhan won the *Daily Mail* prize of £10,000 by flying from London to Manchester with only one stop, the time taken being four hours two minutes, the distance about 150 miles. On 2nd June the Hon. C. S. Rolls flew from Dover to Calais and back without a stop. In 1911 the *Daily Mail* offered a second £10,000 prize for a flight of 1010 miles round Britain. Nineteen competitors started from Brooklands on 22nd September, and Lieut. Conneau, of the French Army, flying under the name of Beaumont, was the first to finish, reaching Brooklands on the 26th September. The time occupied in his flight was twenty-two hours twenty-eight minutes nineteen seconds. He was followed by J. Vedrines on a Morane monoplane, whose time was twenty-three hours thirty-seven minutes fifty-four seconds.

On 1st September 1911 a French aviator, M. Fourny, created a record by flying 722 kilometres 933 metres without a halt, the time taken being eleven hours one minute twenty-nine and a fifth seconds, and three days later another

Frenchman, M. Garros, attained the remarkable altitude of 13,950 feet at St Malo. In the same month aeroplanes were first utilised for the carriage of mails, a special aeroplane service being established for a week between London and Windsor. 100,000 letters and post-cards were carried at a charge of 1s. 1d. each for letters and 6½d. for post-cards, the profits being devoted to charity.

The only form of flying machine which has so far proved successful is the aeroplane. The helicopter, with its horizontal rotating propellers, has, as yet, never approached practical flight, and the ornithopter, with flapping wings in imitation of bird flight, although theoretically more efficient than the aeroplane, has always been a complete failure, probably on account of the difficulty and intricacy of the power transmitting mechanism required.

The manner in which an aeroplane is sustained in the air is exactly similar in principle to the flight of a kite. The simplest form of kite consists of a flat surface, or plane, drawn by means of a string through the air and inclined at an angle to the horizontal. The result of this inclination is that the resistance of the air, being directed against the lower side of the plane, tends not only to stop its forward motion, but also to raise it. In the aeroplane the pull of the string is replaced by the thrust exerted by a rapidly revolving propeller. Various devices, such as using slightly curved instead of flat planes, are employed to diminish, as far as possible, the resistance to forward motion and to increase the lifting action.

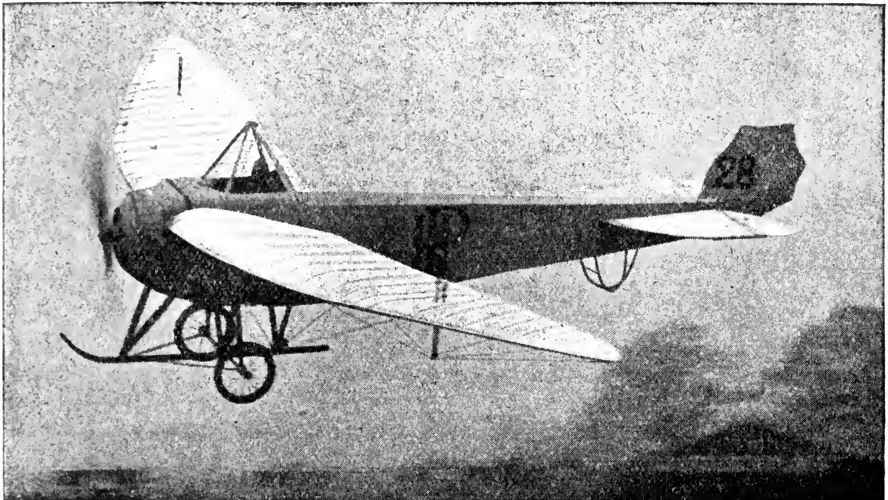


A "SHORT" BIPLANE.

It is obvious that the greater the surface of the plane, the greater will be the resistance and, therefore, the consequent lifting power. Constructional difficulties make it impossible to increase the area of a single plane indefinitely, and F. H. Wenhan therefore proposed, as far back as 1866, the use of two or more surfaces, one above the other. As a result of this proposal, biplanes, triplanes and multiplanes have been used. Particularly may be mentioned the experiments made with multiplanes by Sir Hiram Maxim in 1894.

Modern machines are almost exclusively of either the monoplane or biplane types, the chief advantage of the biplane being the greatest strength of its structure. Against this must be set its additional weight and the extra head resistance encountered, which make it decidedly slower than the monoplane. M. Nieuport, on a monoplane of his own construction, has flown a distance of ten kilometres at an average speed of over 82½ miles per hour. The average speed of a monoplane may be said to be about fifty miles, and that of a biplane about forty miles per hour.

What the future of the aeroplane may be is impossible to conjecture. There have, of course, been numerous accidents, and they, unfortunately, continue, though at a diminishing rate. When, however, the increasing numbers of aviators and the distances they cover are taken into consideration, the proportion of serious accidents is found to be decidedly small. Accidents, too, have been due, at any rate of




THE HANDLEY-PAGE AUTOMATIC STABILITY MONOPLANE.

late years, not to serious defects, but to minor constructional or manipulative imperfections which can only be overcome by time and experience. The most likely cause of trouble is failure of the motor, which stops the forward motion and therefore removes the lifting power. Unless this occurs when the machine is near the ground, the consequences are not necessarily likely to be serious as the descent is gradual and the pilot has time to choose a suitable landing-place. Nevertheless, modern designers are constantly aiming at the duplication of the propelling apparatus as an additional precaution.

Other modern tendencies are the reduction of engine power. At present fifty and even 100 horse-power engines are frequently employed, but there is little doubt that this will be considerably reduced in the near future except for special purposes. There are some who think that the future success of aeroplanes depends upon the attainment of automatic stability. At present the pilot, in addition to controlling the direction of flight by means of a vertical rudder, has to preserve his balance by controlling levers which "warp" the edge of the main planes of the machine. It is suggested that much greater safety would be enjoyed could this balancing be produced automatically by means of a gyroscope, or by any other method, such as by specially shaped planes which will always maintain their stability. There are many experienced aviators, however, who regard automatic stability as by no means desirable, and even objectionable, and no more likely to displace the unstable form

than the automatically stable form of cycle, the tricycle, is likely to displace the unstable but much more convenient bicycle.

Theoretically there is no reason why aerial locomotion should not be successful with engines of but a few horse-power, or even without an engine at all. At present, however, there is little hope of the man-power machine ever resulting in practical flight, in spite of the efforts of hundreds of inventors. The most successful attempt was made by a Frenchman, M. Rettich, in October 1912, who, by means of a combination of tricycle and aeroplane, travelled a distance of just under ten feet at a height of four inches from the ground.

Another type of aeroplane—a sort of aerial boat—which is being rapidly developed, is the form known, for want of a better name, as a hydroplane. The usual landing skids are replaced by buoyant chambers, which enable the vessel to float on water. These vessels are able to travel along the surface of the sea, rise for a flight and return to the sea again, and their importance in naval matters cannot be overestimated.

One great problem which the aeroplane designer has to face is the difficulty of constructing his machine in such a manner as successfully to withstand the strain imposed on the structure when alighting. In the case of the hydroplane (water-aeroplane is, perhaps, a better name) this difficulty more or less completely vanishes, for water naturally provides a far smoother surface on which to alight than the smoothest earth.

As a result, it has been found much easier to design hydroplanes to carry a number of passengers. One of the greatest difficulties is to construct machines capable of withstanding heavy seas, and also to provide for a sufficient petrol supply for the necessarily long journeys which must be undertaken. However, those most competent to judge are confident that not many years will elapse before a hydroplane capable of crossing the Atlantic will be constructed.

## CHAPTER X.

Rapid transit between the business quarters of great cities and their suburbs is entirely a modern problem, and mostly a very recent one. The brilliant achievements of street railway engineers in the present generation have only kept pace with urgent necessities. The growth of many great cities in Great Britain and America has been wonderful, and has been maintained at a constant rate. Such a growth means increase in the peopled area of each city, and thus the distances to be traversed from the residential suburbs to the business district are perpetually increasing.

As it is in cities that the multiplicity of traffic occasions the most inconvenience, it is also where the need for the rapid transit of goods and passengers is most marked.

Yet so effectually had public enterprise and capital in Great Britain centred in the steam locomotive and the railroads in connection there-

with, that for thirty or forty years following urban transportation was sadly neglected, and, particularly in London, facilities for rapid movement left much to seek. Prior to the construction of the Underground Railway, rapid transit

THR FIRST OMNIBUS.

in London was represented by the omnibus, first started July 1829, and the hackney coach or cab.

But in the interval the Americans had long perceived the merits of the tramway system in accelerating the movements of the urban population. In New York, the Fourth Avenue (Harlem) Tramway was chartered in 1831, and for twenty

years maintained a monopoly of the street railway traffic, after which a general extension of the system followed in the large cities. Philadelphia and Boston started tramways in 1857, and from that period to the present, the growth of tramways in America has been so widespread that over 500 towns and cities are equipped with

PATENT SAFETY CAB.

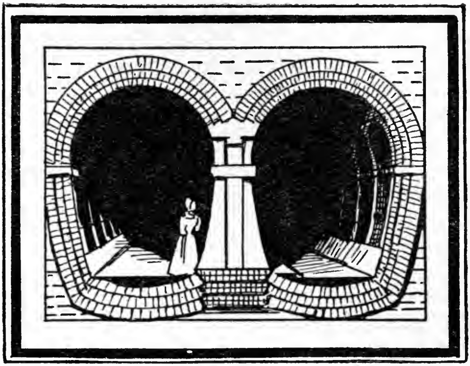
this means of rapid locomotion. As we shall see, although horse traction was in the first instance resorted to, yet this was, in many instances, succeeded by cable system, and latterly by electricity.

In 1858-59 an enterprising American, G. F. Train, obtained permission to establish several short tramways in this country. But the rails were of a most objectionable and inconvenient

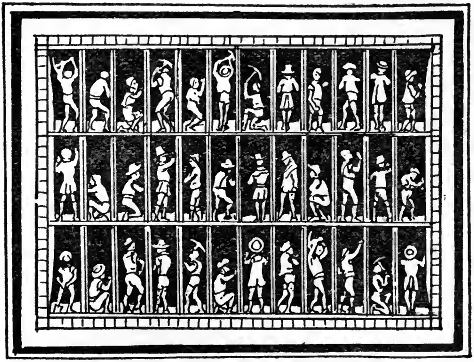
form, their projecting flanges making it difficult and even dangerous for ordinary vehicles to cross the line save at right angles to the line. The result was that they were soon decreed a nuisance by the several local authorities, and those in London having been laid without special Parliamentary sanction, their summary removal was ordered.

But ten years later, an agitation having been vigorously carried on meanwhile, and the metropolitan toll-bar system abolished, tramways reappeared in force. Several companies were incorporated for London in 1869-70, and in the course of the next decade the larger provincial towns had followed the example of the capital. There are now well over 1000 miles of tramways built and in operation in the United Kingdom, carrying annually an enormous number of people. In London alone the tramway passengers amount to between 700 and 800 millions every year.

The growing development of tramways, which made it possible for the industrial classes to avail themselves for the first time of the advantages of rapid locomotion, naturally led to still further efforts on the part of the projectors to lessen the cost of working, as well as to increase the speed. Various patents had been taken out for cable traction, *i.e.* in which a rope should travel enclosed in an underground pipe, with a grip attachment on the cars capable of clutching or releasing the moving cable. The first practical application of this plan was made in San Francisco in 1873 by the building of the Clay Street cable line. The road, which is about a mile



No. 1, showing construction.



No. 2. Iron shields with a workman in each compartment.

THE THAMES TUNNEL.

long, has, in parts, a gradient of one in six, and rises to a height of 300 feet above its low-level terminus. Animal traction was, of course, impracticable over such a route, and the success of the new cable system being ascertained, it was applied to other lines, San Francisco alone having 100 miles of cable lines in operation. Ten years afterwards Chicago built its first cable line, and it was also about the same time adopted for the Brooklyn Bridge Railway, which conveys an average of 35,000 people in the single hour between 5 and 6 P.M. daily. It was also applied to the great Broadway line.

This country was somewhat tardy in using cable traction, and, when adopted, was only on a very limited scale, one great reason being the relative narrowness and crookedness of the streets. The Highgate Hill cable line was opened in 1884, and other lines were soon built in Edinburgh, Birmingham, Bristol and Matlock. The Brixton tramway superseded horse-power by a cable. Australia and New Zealand also largely adopted the cable system.

But the greater advantages of electricity were not long in becoming manifest, especially in the United States. In New York, Boston, Chicago and Philadelphia the electric trolley system has grown almost universal, whereby speed has been doubled, and the heart of the city made accessible at slight cost to the dwellers in the suburbs. After a considerable interval electric tramways secured a footing in Great Britain, such towns as Glasgow, Nottingham and Norwich preceding the capital, which did not enjoy such a service

until 1901, when the Shepherd's Bush and Kew to Southall lines were opened.

There can be no question, however, that no matter how conservative London may have been as regards speed in transit, the establishment of some system partially effecting this for the mass of the population would have previously taken place but for the building of the underground Metropolitan Railway. When the idea was first proposed of a railway for human beings to travel along under the streets and among the sewers it was regarded with contemptuous amusement. But London's stupendous growth demanded new and improved means of communication: the streets were already too congested with traffic: the choice lay between a railway over the top of the houses or beneath the pavement, and the latter alternative was the one chosen. Of course, the omnibus and cab interests, unconsciously following the example of their predecessors, the stage-coachmen, were fiercely opposed to the scheme, but when powerless to prevent it, wreaked their spleen in bitter jests and sarcasm.

In 1854 the first Act of Parliament was passed authorising the line, and the works commenced in 1860. Three years later the first section of the line—Paddington to Farringdon Street—was opened, in which year the Lords' Committee recommended that the inner circle of the further projected lines should abut upon, if not actually join, most of the principal railway termini in the metropolis. The total length of the inner circle is 13 miles 176 yards, two miles of which

length being laid with four lines of rails, and the total length of the two underground systems is over forty miles. Even when the utmost precautions are taken, tunnelling through a town is a risky operation. Settlements may occur years after the completion of the works; water mains may be broken in the streets and in the houses; stone staircases may fall down; and other unpleasant symptoms of instability may show themselves. But rapid transit was the goal in view; in the case of London, and, indeed, all large cities, railways designed for local service must of necessity be either sunk below or raised above the street level; and London public opinion was against the elevated railway, which has had such a great success in New York and Liverpool. By means of the new "Underground" it became possible, no matter how congested the street traffic, to reach the Bank from Hammersmith, a distance of seven miles, traversing or rather following the line of most resistance in twenty minutes. Here, then, we see a vast improvement as regards economy of time. In 1800 a walk (there was no other popular means of transit) to the Bank from Hammersmith occupied about two hours; in 1850 the omnibus did the journey in fifty minutes.

But New York was soon to be better served than London. In 1867, the first attempt was made to improve existing means of transit between the residential and the business quarters of the city by the construction of an elevated railway actuated by a wire rope and a stationary engine. The undertaking passed into other hands in


ELEVATED RAILWAY, NEW YORK.

1872, and by 1880 the elevated railway system was worked over thirty-four and a half miles of line; 165,000 passengers on an average were carried per day, and trains ran every two minutes during the morning and evening, with a somewhat longer interval in the quieter hours of the day. The railway is supported on square, wrought-iron lattice-work columns let into cast-iron base blocks, founded on brickwork and concrete, at a distance of from thirty-seven to forty-four feet apart. In parts, where the street traffic is crowded, a single row of columns is planted in the line of each kerb, on the upper ends of which a pair of longitudinal girders are fixed to carry a line of way twenty-two and a half feet high above street level, at each side of the street. In other situations the two lines of way are supported at a height of twenty-one feet on longitudinal girders in the middle of the street fixed to transverse girders which span the street and are carried on columns at the curbs. The system certainly has its drawbacks, and does not make for beauty or picturesqueness, but for a time, even when the locomotives were worked by steam, it made New York the most admirably served city in the world in the matter of rapid transit, it being possible to go from Harlem to the Battery, nine miles, in twenty-one minutes.

Meanwhile, the world's greatest city had rested content with the facilities afforded by its underground railway and its horse-traction tramways in spite of the daily increasing evidences that these were inadequate to the needs of the huge metropolis.

The first step in that wonderful change which, in a few years, entirely altered London's methods of locomotion, was the construction, commenced in 1886, of the City and South London Railway, the first London electric railway. Its original length was 3½ miles, and it was constructed in two tunnels running side by side at a distance below the surface varying from forty to eighty feet. The success of this venture was quickly followed by the construction of the Central London Railway, which originally set up a record in cheap transit by conveying passengers from the Mansion House to Shepherd's Bush for a charge of twopence. Then came the conversion to electric traction of the old Metropolitan and District Railways, and the building of a number of deep level tubular electric lines to all parts of the metropolis. There are now many miles of underground electric railways in London on which a continuous service of trains is maintained, with intervals of only two or three minutes, from about 5.30 a.m. till well after midnight.

On the earlier lines separate electric locomotives were employed to draw the trains, but now the motors are placed in the front of the passenger coaches, this method giving rise to less vibration. Driving such a train is simplicity itself, the whole of the complicated electrical connections required for starting, stopping and speed regulating being controlled by a single handle.

The marvellous changes in the methods of transit under ground have been equalled by the

alterations on the surface. London's old horse tramways were at last superseded by electrically driven tramcars, and the old horse omnibuses have given place to buses driven by motor-power. These are constructed and controlled in exactly the same manner as the modern motor cars already described, only differing in that they are designed to carry a large number of passengers at a comparatively slow speed. Most of the omnibuses at present in use in London are driven by petrol motors, but some are steam driven.

For many years London was far behind many of even the lesser provincial towns in the matter of tramways. Long after rapid and efficient electric tramways had been in operation in all the large, and many of the small, provincial towns, the metropolis still clung to its old horse tramways. However, these had at last to give way to the ever-increasing demand for progress and greater facilities, and large numbers of electric cars now run daily in all but the most central portions of London. For many years the London County Council sought in vain for power to bring its South London tramways over the bridges and along the Embankment. At last all opposition was overcome, and the Northern and Southern systems were linked up. Another link has been provided by the construction of a shallow underground subway passing from the foot of Waterloo Bridge under the Strand and Kingsway, coming to the surface again in Bloomsbury. Special low cars had to be constructed for this journey.

In some towns electric tramways are operated by what is known as the overhead system, electric power being taken from an overhead wire. In other places the conduit system is employed, the wire conveying the current being placed in a slot in the road between the tram rails. The latter system is far more expensive to construct, but has the advantage of being much less unsightly than the former.

Another objection to the overhead wire construction is the obstruction caused by the posts which are necessary to support the wire. In London both methods are in use, the overhead construction being employed in the outlying districts, and the conduit system in the busier streets.

Another system which has been adopted in Paris and in some English towns is the surface contact system. A series of metal studs are placed, at intervals of about nine feet, between the tram rails. By means of an electro-magnet on the car each stud is automatically connected to the electric cable beneath while the car is passing over, the electric current being collected from each stud in turn by a long metal shoe, similar to that used in the conduit system. In each of these methods the current returns through the rails.

In order to compete with motor omnibuses, a new type of rail-less tramcar is being experimented with. Electric power is taken from an overhead wire by means of a flexible arm, but the car is free to travel on any portion of the road. Traffic delays will thus be minimised,

and the cost of installation enormously reduced, although, since there are no rails to act as a return conductor for the electric current, a second overhead wire is necessary. This system has already been adopted in a number of continental cities and in one or two towns in the North of England.

Electric traction has not at present been very extensively adopted on above-ground railways. There is little doubt that its economy in working, and the rapidity with which full speed may be attained, will ultimately lead to its adoption, at any rate in suburban areas, where stations are close together and stoppages therefore frequent. The largest electrification scheme so far completed is that of the London, Brighton and South Coast Railway Company, who have converted some sixty-two miles of single track in their suburban area to overhead electric traction with happy financial results. They are said to be contemplating the electrification of their main line to Brighton. The London and North-Western Railway Company have also commenced the electrification of their suburban line; the London and South-Western and other Companies are likely to follow suit at no late date.

The chief reasons for delay are probably to be found in the enormous expense incurred in such a radical change, and also in the uncertainty that still exists in the minds of engineers as to which is the best system to adopt. For many years the rivalry between the direct or continuous current system, such as is used on the London underground railways, and the single-

phase alternating current system, adopted by the London and Brighton Company, has continued without any definite victory for either side. There is another system in use on several continental lines on which what is known as a three-phase alternating current is employed at a high pressure. This system has been shown in Germany to be capable of a speed of 125 miles per hour, but it is more adapted to high-speed main-line working than to short suburban railways. Although it is probable that the electrification of main-line railways will ultimately come, it will certainly not be for many years, and the innovation will be gradual. There will be no sudden change such as was at one time imagined.

A plan which is supposed to combine all the advantages of electric traction on an ordinary steam railway track is being tried by the Great Central Railway. A comfortable coach, capable of accommodating fifty passengers, is fitted in its front compartment with a six cylinder petrol motor, which drives a specially constructed electric generator. The current from this generator drives electric motors, operating directly on the axles of the car. The system is said to be cheap and efficient, and a speed of forty miles per hour can be attained on the level. It seems probable that this system will ultimately displace the small self-contained steam-driven passenger coaches which have of late years become so general on small branch lines.

A type of railway of which great things are sometimes prophesied is the mono-rail, on which the cars run on a single rail. One method is to

suspend the car from a single overhead rail, and this has been successfully adopted on an electric line of $8\frac{1}{4}$ miles which runs through the Wupper Valley in Germany. Fifty passengers are carried in each coach at a speed of over thirty miles per hour. In Belgium experiments have been made with cars which are built in duplicate and are hung on each side of a supporting rail fixed a few feet above the ground, the duplicate carriages thus being made to straddle across the rail. The first railway of the sort was constructed at Cheshunt, in Hertfordshire, as far back as 1825 for the conveyance of bricks. The advent of electrical driving has drawn attention to its adaptability for high speeds, and Mr Behr has suggested that a railway of this type should be constructed between London and Brighton, and between Liverpool and Manchester, to run at 120 miles per hour. The distance of thirty-two miles between the two Lancashire towns was to be covered in fifteen minutes. A more recent proposal is the construction of a Behr mono-rail through Pelham Bay Park to City Island, New York City.

The most original class of mono-railway is that invented by Louis Brennan (inventor of the Brennan torpedo) in England and by Richard Scherl in Germany. Brennan first exhibited his system in 1907. The track consists of a single rail laid on the ground. On it the car is balanced by means of a gyroscope. This is a very simple piece of apparatus, and consists merely of a heavy fly-wheel rotating at a high speed. Its own momentum tends to keep it continually rotating

in the same plane, thus maintaining the balance of the car in which it is fixed. Mr Brennan exhibited in December 1909 a successful car on this principle, weighing twenty-two tons and carrying forty passengers. It was driven by petrol motors, and was balanced by two gyroscopes, each weighing fifteen hundredweights, and making fifty revolutions per second. In order to minimise friction, the gyroscopes were placed in a vacuum chamber. Under these conditions they continue to revolve for several hours after the engine has been stopped, thus obviating any danger of accident due to failure of the engine. It is thought that a gyroscopic mono-railroad might be particularly useful for pioneer work in rough country.

In London, and in many other important cities, there is a growing need of a subway for freight trains, so that heavy goods can be taken from ships and ferries, and carried on belt-line cars to warehouses and stores in different parts of the city. By some such system much delay and traffic congestion might be avoided in many of the largest cities of the world. A tunnel freight road would greatly promote local prosperity as we'l as the convenience of shippers.

Rapid locomotion is a necessity of modern city life; in satisfying this necessity a multitude of benefits accrue to the whole community. The result of all this costly effort must influence the future course of civilisation, and perfect in a decided fashion the modern city which owes its present congestion to the development of steam rail-roads.

Ian Maclaren recently wrote of Americans: "No man goes slow if he has the chance of going fast; no man stops to talk if he can talk walking; no man walks if he can ride in a trolley-car; no one goes in a trolley-car if he can get in a convenient steam car; and by and bye, no one will go in a steam car if he can be shot through a pneumatic tube. . . . There is nothing," he added, "an American cannot do, except rest."

This reference to the pneumatic tube suggests the high hopes which have from time to time been entertained of this agent as a means of rapid transit.

Early in the last century Medhurst made a proposal to construct a railway on this principle, the carriages moving through an air-tight tunnel. A short pneumatic railway was laid down in the Crystal Palace grounds in 1865 by Mr Rammel. It consisted of a single line of rails in a tunnel 600 yards in length, along which ran a carriage. Motion to the latter was conveyed by means of a fan or hollow disc twenty-two feet in diameter, which either condensed or rarefied the air as required, according to the adjustment of certain valves. This experiment was, however, soon discontinued, and the only way air is used now in the propulsion of vehicles is in a compressed state, and working a compressed air-engine.

Like the pneumatic tube, the moving platform, shown in operation at the Paris Exhibition of 1900, has not proved as adaptable to the requirements of rapid locomotion as was at one time

anticipated, and has not been brought into use commercially. A suggestion of a somewhat similar nature was brought forward in 1911 for a non-stop railway for use in busy districts. The cars are to be operated by means of a spiral screw-thread on a revolving horizontal shaft

MOVING PLATFORM, PARIS EXHIBITION, 1900.

which runs the whole length of the railway. In the stations the pitch (or distance between the turns of the spiral) would be small, thus moving the car at a low rate of speed, not exceeding three miles per hour. Between the stations the successive turns of the spiral would be more widely separated, thus carrying the train along more quickly. It is claimed that this scheme is very cheap in construction and working, and will carry more passengers per hour than any other

method yet adopted. It has not yet been given a practical trial.

When one is asked, "What is the value of rapid transit? what difference does it make whether we reach Edinburgh in eight hours or eighteen, or gain Cologne from London in sixteen or thirty hours? the answer to both is easy. Despatch is not only the soul of business, but international understanding and good-will largely depend upon facile intercommunication. According to Professor Bryce, in enumerating the causes of Anglo-American amity, "the ocean steamers have done perhaps most of all, because they have enabled the two peoples to know each other." When it was a two days' journey from London to Calais, a comprehension of France, such as is enjoyed to-day by many thousands, was impossible to Englishmen.

As to the far developments of Rapid Transit only the poet and dreamer can tell us, he who has

> ". . . dipt into the future far as human eye can see,
> Saw the vision of the world and all the wonders that would be;
> Saw the heavens fill with commerce, argosies of magic sails,
> Pilots of the purple twilight, dropping down with costly bales."

Some twelve or fifteen years ago the ingenious author of "Anticipations" expressed his belief that the motor—hired or privately owned—would solve for first-class passengers the problem of transit in the future. It would be capable of a day's journey of 300 miles or more; one would change nothing—unless it were the driver—from

stage to stage, moving as one wished and resting where one wished, combining all the attractiveness of old-fashioned posting, with quadruple and quintuple speed. This forecast has been fulfilled sooner, perhaps, than even its author imagined possible.

"No one," wrote Mr Wells, "who has studied the civil history of the nineteenth century will deny how far-reaching the consequences of changes in transit may be. . . . Upon transport, upon locomotion, may also hang the most momentous issues of politics and war. The growth of our great cities, the rapid peopling of America, the entry of China into the field of European politics are, for example, quite obviously and directly consequences of new methods of locomotion."

Therefore, we may say to the opponents of this great branch of material progress to-day:

> "Decry all speed and laud the leisur'd mole.
>
> . . . . . . . . .
>
> The world moves yet but fleeter to its goal."

FINIS.

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